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ACADEMIC FREEDOM AND ACADEMIC RESPONSIBILITY

By KARL T. COMPTON

President of the Society

Scarcely a week goes by without some significant pronouncement in affirmation of the principles of academic freedom. It is well that this is so, for academic freedom is a precious heritage, an inherent part of those liberties which our forefathers won for us, through long struggle, passed on to us through tradition, and safeguarded for us by our American Constitution. In fact, the roots of academic freedom go much farther back in history than do our civil liberties generally, for they are based on the age-old respect for the knowledge and disinterested pronouncements of scholars.

One fundamental principle, not emphasized often enough in current discussions, is that freedom, academic and political, carries with it a responsibility of being worthy of that freedom. Freedom, in the last analysis, can only be won and maintained by deserving it. If we concentrated more effort on being worthy of freedom, we should not have to get so exercised over danger of losing it. In the academic field, what is the most important thing for us to do to secure academic freedom? Just what is "academic freedom"?

Academic freedom *is not* license to rant or to promulgate half-baked ideas or prejudices *ad libitum*. Nor is it academic freedom to loaf or to stagnate on the teaching job, with guarantee of life-long support from funds paid by students to secure an education or donated by philanthropists and made tax exempt by our government in order that the great cause of education shall be furthered. The organized defense of academic freedom has been so effective that college administrators have a healthy hesitation about dismissing (or not reappointing) instructors even for good cause. It is said that the safest job-holder in the United States is the professor of sociology who publicly advocates some un-American doctrine for, however incompetent he may be, he cannot be dropped without charge that he is being muzzled or disciplined for expressing his convictions—an abuse of academic freedom.

Academic freedom is freedom and opportunity to search for the truth and to declare the results and conclusions thus drawn from competent and careful analysis.

Academic freedom does not exist as an inalienable right; it is accorded by the public to the academic profession out of the respect which it has earned. If ever the public loses respect for the wisdom, judgment and social value of the teaching profession as a whole, then academic freedom will, in my judgment, disappear.

So I should like to emphasize *academic responsibility* as being essential to, and even more important than, academic freedom. Too much constructive thought and effort cannot be given to improving the value of our educational institutions to the communities which they serve. Any faculty member who is stagnant, incompetent, erratic, prejudiced, uninspiring, unproductive or otherwise unable to command the respect of thoughtful people by the quality of his performance in his job, is a real threat to academic freedom. Likewise, the college administration which does not, with reasonable effectiveness, maintain an able staff and an alert program of socially valuable activities, is a threat to the future freedom and opportunity of the whole academic world. We defend academic freedom in our writings and speeches. May we also safeguard it by our actions, by working for that quality of high accomplishment in our educational institutions which will command the continued respect of the public on which academic freedom depends.

EMPLOYMENT SERVICE

The Society maintains an employment service for its members. If you are interested in changing your position, file in the secretary's office a statement of your education, experience, references, and photograph.

If you have a vacancy in your department we should be glad to have you list that with us.

There is no charge to members for the above service.

F. L. Bishop, Secretary,
University of Pittsburgh,
Pittsburgh, Pa.

THE JUNE MEETING OF THE SOCIETY

The Pennsylvania State College—State College, Pennsylvania

By J. E. KAULFUSS

Professor of Highway Engineering

The 47th annual meeting of the Society for the Promotion of Engineering Education takes place at The Pennsylvania State College, State College, Pa., from June 19–23, 1939.

With the expectation of an attendance of 1,800 or more, local committees numbering 23 whose personnel comprise over 225 persons have been at work on arrangements, actively since the first of the academic year. The plans to receive, accommodate, provide for, and entertain the visitors and to arrange for proceedings and extra-proceeding activities of the meeting were well under way, already in January.

Actual details of program, registration, accommodations, entertainment, etc., will be circulated to or available to those in attendance, or contemplating to be so, in regular convention style, before June and at the time of registration.

Committees include a Central Committee, Professor C. L. Kinsloe, Chairman, and various others such as Meetings and Conferences, Council Meetings, Information, Service to Guests, Transportation, Publicity, Registration, Housing, Trips, Care of Children, Recreation, Entertainment, President's Reception, and Banquet and Group Dinners.

Ladies' Committees include Reception, Hostesses, Trip and Transportation, Flowers or Decoration, Entertainment, Recreation, and General Committee.

June is a busy month on the campus of The Pennsylvania State College. On the 12th, the June commencement occurs, at which 1,000 or more graduates will receive their undergraduate degrees and at least 100 others will receive advanced degrees.

Inter-Session, on the campus, begins immediately. This is a three-weeks course taken by graduates, mostly teachers and adults to the number of over 400, in subjects of teaching and psychology. Many parts of the institution, especially those which are on an eleven-month basis like Agriculture are active throughout the summer. The regular summer session begins after the first of July.

ENGINEERING UNITS B TO E

Also a main street of town, West College Ave. Power Plant in the right background—also the University Club. Petroleum Laboratory at extreme right.

Immediately following commencement, various summer camps will have begun, located within 15 and 25 miles of State College. These are the civil engineering surveying camp for 8 weeks, 2-year and 4-year forestry camps for 8 weeks, geology for 8 weeks, petroleum and natural gas for 3 weeks, and mining for 2 weeks. The last-named is undertaken in the limestone mines at Bellefonte, the county seat, ten miles distant.

Other scheduled events for June are as follows with their anticipated attendances indicated:

June 7– 9	Pennsylvania Millers and Feed Dealers Association
June 12–14	Extension Service Conference—4 H Clubs—50
June 13–15	First Farmers of America—1,100
June 16	Farmers' Field Day—2,000
June 19–23	Short Course for Farm and Country Pastors—100
June 19–23	Society for the Promotion of Engineering Education—1,800
June 26–27	Institute of Social and Family Relations—150–500
June 26–30	Water Works and Sewage Associations—150–250

Divertissments and attractions, on the campus, in the borough (city), and in the farm, mountainous, mining, and scenic area of central Pennsylvania are many. These include:

The orchards, fields, experiment plots, wood lots, poultry, sheep, swine, cattle, and gardens of the School of Agriculture, the land of which is contiguous to the campus proper;

The College dairy operated on a limited commercial basis, locally retailing milk, cream, ice cream, cheese, and butter, and shipping some of the same to New York City and other markets;

In the Institute of Animal Nutrition, the respiration calorimeter of a size sufficient for making experiments on mature cattle, which though completed in 1902 is the only one of its kind in the world;

The oldest experimental plots in the country, and the United States Experiment Station;

The Engineering Experiment Station and the principal engineering research projects on fuel infusion, lubrication, Diesel engines, and heat transmission;

The Mineral Industries Art Gallery comprising 105 paintings valued at $25,000, the only one of its kind and relating to the state's industries and resources;

Woodworking, forge, and machine shops, foundry, materials laboratories, hydraulic, electrical, railroad mechanical, and mechanical laboratories in the Engineering School;

The modern $166,000 heat and power plant of the institution;

Also a main street of town, West College Ave. Power Plant in the right background—also the University Club. Petroleum Laboratory at extreme right.

RECREATION HALL

Indoor sports center and gymnasium, seating 6,000 or more for boxing and basketball, 5,000 at commencements; 18-hole college golf course to the left across U. S. Route 322. Nittany Lion Inn obscured in view.

The Nittany Lion Inn, a hostelry on the campus, and the college 18-hole golf course which adjoins the campus proper, and vicinal country clubs;

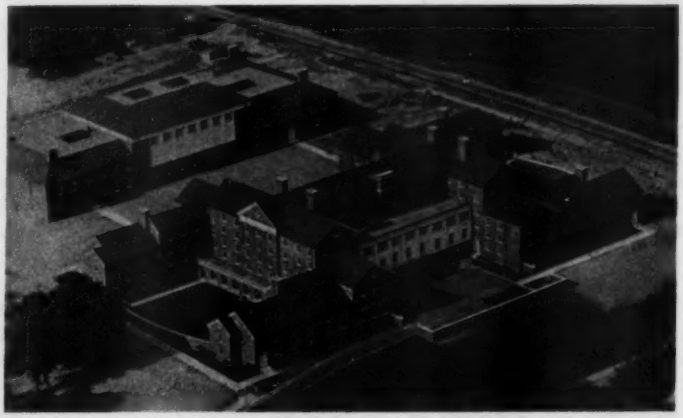
A swimming pool in the new White Hall and the Glennland Apartment swimming pool in the town which is the largest indoor pool in Pennsylvania;

The adjoining college and borough sewage disposal plants of different types, and water supplies likewise;

Tennis and hand-ball courts on the campus, riding stables, a 12-alley bowling alley in the town, roller skating rink, and the like;

A Catholic Church and chapel and Protestant Churches, nine in number, including Christian Science and Oxford groups;

State Parks, Forest Preserves, and Game Preserves within easy motoring distances, such as Spruce Creek, Greenwood Furnace, Bear Meadows, Poe Valley, etc.;



FRANCIS ATHERTON AND WHITE HALLS

New quarters, housing 500 women; to be used as quarters for S. P. E. E. attendants; college farms in background extend back 3 miles or more; road leads to the left to the nearby poultry houses, cattle and sheep barns, and Dairy Building.

C C C camps which have opened many miles of auto roads and trails in the forests and mountains of the area;

Numerous caves such as Penn's, Woodward's, Alexander's, Indian Echo, Veiled Lady, etc., Penn's Cave being extraordinary in that it is traversable only by boats;

Picnic, camping, and outing places like Stone Valley, Moshannon, and the College Nature Study Camp in the Seven Mountains;

Juniata College and the Pennsylvania Reformatory School at Huntingdon, Pa., Rockview Penitentiary near Bellefonte, where electrocution sentences are carried out, the Penitentiary Nurseries, etc.;

Scenic lookout points such as Skytop, Penn's View, Nittany Mountain View, and others;

The Big Spring at Bellefonte discharging 11,500,000 gallons daily, one of the large springs in the United States;

The BIG TROUT in the stream passing through Bellefonte, viewed (and fed) by thousands annually.

NEW OLD MAIN—the heart and center of The Pennsylvania State College. Originally this was the Farmers' High School of 1855; in June, the S. P. E. E. registration center.

FISHERMAN'S PARADISE within ten miles of State College is the only one of its kind in America. It comprises three miles of beautiful Spring Creek, truly a fisherman's paradise. Millions of trout and bass are propagated here annually. Here is provided supervised fishing during the trout season. A special pool is set apart for ladies. Fishermen who check in are permitted to catch ten trout daily, permitted however to keep only two. Barbless hooks are used and fishing must be done with fly.

The town of State College has service clubs, Kiwanis and Rotary.

The home of the Amish, in nearby fertile and picturesque Kishacoquillas Valley, not far from Greenwood State Forest Park, settled in 1760 by Scotch-Irish, notably the community of Amish Mennonites whose ultra-conservative customs of beards, sombre dress, using horses on the highway, etc., always prove interesting.

Some further information about Penn State itself might be of interest and early information to prospective visitors to its campus, such as follows.

The Graduate School has 500 enrolled this semester; during the summer session in July and August, the number is about 1,100. Currently in Chemistry and Physics, there are 78 in chemistry proper, 24 in chemical engineering, and 18 in physics, totalling 120. In Engineering there are 28 graduate students, while in Mineral Industries there are 30.

In research, the largest amount is generally Agriculture in land-grant colleges, and this is true of Penn State. For example, figures for 1936–37 show 113 projects in agriculture involving about $325,000. Sixty projects were undertaken wholly or chiefly by federal funds, $157,000; 61 projects by state funds and produced income, $160,000; and 12 projects with $3,000 of commercial grants and miscellaneous monies.

For the present year, in the Schools of Engineering, Chemistry and Physics, and Mineral Industries, research funds will have been expended as follows: in engineering, $60,000 total, of which over $16,000 comes from industries; in chemistry and physics, $118,000 of which about $90,000 comes from outside; and in mineral industries, $96,000 of which over $39,000 is from commercial sources.

The research work in the Engineering School in which is the Engineering Experiment Station has been notable, as stated previously, in lubrication, fuel infusion, Diesel engines, and heat transmission.

In addition to resident instruction and activities, centers in central Pennsylvania, graduate work, and research, The Pennsylvania State College carries on extensive correspondence, extension, and like interests.

Its formal instruction by extension and correspondence involves 18,282 students. The nearly 13,000 in class program work is composed of 6,589 in engineering and liberal arts, in industrial education 237, in mineral industries 4,282, and in teacher training 1,583. In correspondence (5,591 total) are 4,710 in agriculture and home economics, 551 in engineering and liberal arts, 67 in industrial education and mineral industries, and 263 in regular teaching training, exclusive of the five college centers.

In general extension, akin to adult education, informal instruction is given in about 50,000 contacts, as in short courses, conferences, conventions, and clinics. In Smith-Lever work in agriculture, it is estimated about 1,000,000 persons are directly affected by college services and activities, the equivalent of about 480,000 contacts throughout the year.

In January, 1939, the current State Authority $5,000,000 new buildings program was announced as being well over 80% completed in contract, the stipulated completion date being in early summer.

In conclusion, the foregoing in addition to another, the first, article in the January issue of the JOURNAL, also by the writer, is expected to give, not only to the acquaintances of, but the stranger to, "Penn State" such a picture of its physical plant, surroundings, resident work, research, extension, correspondence, summer school, and graduate activities as will encourage members of the Society to attend its June meeting at The Pennsylvania State College, in State College, Pa., June 19 to June 23, inclusive.

Those who know Penn State and are of it consider it a great institution, a prominent state university in fact, and an exceptional land-grant college.

A warm welcome awaits all visitors at any time, and at the S. P. E. E. meeting in June, especially.

THE E. C. P. D., THE GOOD COLLEGE, AND THE T. B. M.*

By SAMUEL B. FOLK

Associate Professor of Mechanics, The Ohio State University

The December 1938 Supplement of the JOURNAL OF ENGINEERING EDUCATION carries the annual list of the accredited undergraduate engineering curricula. Each professor can bury his copy on his desk with other dust-laden bulletins, either smug in his pride that his institution merited the national trade mark, or secure in his conviction that no prospective student will discover that his college did not choose to be examined.

Some had wondered if there had been any shocks arising from the E. C. P. D. In the December issue, D. S. Elliott of Tulane University has given us an insight into "The Impacts of the E. C. P. D. Accrediting on Physics." Perhaps his comments are equally applicable to all engineering. Let us examine two items.

The first is (to quote) "the exercising by the practicing engineer through his national society of too great an influence on engineering education." If this control is real, it might be deleterious for the "healthy growth and experimentation in the respective engineering divisions." The publication lists 96 different names in the Committee on Inspection. Of these 82 are from colleges, 13 representing the S. P. E. E., with 12 of the 13 representing other societies as well. The writer is not intimately familiar with the committee's work, but was impressed, when his own school was inspected, by the thoroughness and good intentions of the men serving in that capacity. However even if they are college men but appointed by other societies, it may indicate a warning, and represent a trend which should at least be observed. Moreover, after the data were collected by inspections, some group must have held veto power on the final decisions.

The second result of accrediting curricula (to again quote) will be "a sacrosanct attitude . . . of the heads of degree-granting departments [carrying] the undivided responsibility for all useful decisions, not only concerning the sciences in particular, but all other 'service' departments as well." Executive orders, such as dropping an hour of strength of materials in order to add time

* Tired Business Man.

in machine design to teach rule of thumb methods, are becoming too prevalent for laughter.

The philosophy behind these two items (and others mentioned by Professor Elliott) should be viewed with alarm by all professors and administrators. They involve more than just a passing note in the organization of our institutions of higher learning.

The Good College

When discussing the accrediting by the E. C. P. D. one infers that the "good college" is meant. Just what is a good college? How is one to know it when one sees it? Are they large colleges or small? The writer is certainly in no position to answer these questions. He can merely point to a study that has been made by the Carnegie Foundation for the Advancement of Teaching entitled, "The Student and His Knowledge. A Report to the Carnegie Foundation on the Results of the High School and College Examinations of 1928, 1930 and 1932." No T. B. M. and few professors have probably read it. They should read the 31 page pamphlet summarizing it entitled "How Good Are Our Colleges?" prepared by Goodwin Watson for the Public Affairs Committee.*

Members of the S. P. E. E. should be interested in some of the findings. In the first place, the size of the college is apparently not an index of "recognized" Arts colleges in Pennsylvania. Next, the dullest student in one "recognized" college surpassed in the knowledge test, the brightest student in another college. This ought to indicate that there might be wide differences even in accredited engineering curricula. It is pointed out that this may be due partly, but not entirely to the selection of students. Some Arts colleges really teach more than others, and certain courses may prepare the student better to pass the 12-hour Carnegie test embracing fine arts, history, social studies, world literature, and natural sciences. Of course (some say), the engineering schools neglect these subjects. But, the report says, there are still unexplained differences in the student's knowledge. For example, in College A, of 47 engineering students tested, all but one showed a gain in knowledge between the sophomore and senior years, and the average gain was 7 points. In College B, of 79 students of engineering, nearly one-third showed a loss of knowledge, and the average gain was 4 points. Do these shocking facts cause any impact on the E. C. P. D. accrediting program?

Again the usual objections will be heard, that such a test is unfair to engineers, and that they should be tested in mathematics,

* Pamphlet No. 26 (10¢), Public Affairs Committee, Inc., 8 West 40th Street, New York City. The comments in the next two paragraphs are by special permission.

where, many engineers believe, learning is progressive through the years. Yet the results of tests given to 2800 students in 10 colleges show that the juniors did better than the seniors, the sophomores better than the juniors, and the freshmen best of all. "The top 25 per cent," says Professor Watson, "of the Pennsylvania high school students who had had only one year of algebra surpassed, on the same test, 40 per cent of the students who had had two years of algebra, and 30 per cent of a more select group who had finished 5 semesters of algebra."

If colleges in general, in Pennsylvania, are like this, just how can any committee select the curricula to be accredited? Will curricula in engineering schools vary as widely as Arts colleges? Are we setting up a rather low minimum standard? Is there any incentive to exceed that minimum? Would it be desirable to have the accrediting, as now done by the E. C. P. D., done by the S. P. E. E. and the National Council of State Boards of Engineering Examiners, but with the help of the Carnegie Foundation and perhaps a broader group like the American Association of University Professors? Would this lend a more continuous and absorbing interest in the problem?

Enter the T. B. M.

The system probably solves the problem as far as the State Boards are concerned. At least it gives a slide rule answer. It does not solve the problem of the tired business man, the farmer, or the laborer—the parent—who is trying to help his son select an engineering school. Everyone decries waste of time, and unproductive use of native ability. Yet the high school graduate may choose an engineering college which can contribute little to the development of his talents. If father has not heard of the E. C. P. D. it is unfortunate for the son, who, with college diploma in hand, discovers that he cannot be a Registered Engineer for some time. It should not be necessary for him to search the dusty files of an engineering journal. True to form, the average professor who spends his time developing a good course, turns out to be a poor advertiser. Someone—some organization, perhaps the S. P. E. E.—ought to put these facts into the hands of the high schools, the vocational advisers and the parents. Until this is done, the E. C. P. D., the *Good College* and the T. B. M. cannot be expected to get together—and society may discourage and lose the services of a first rate engineer.

FIELDS FOR WHICH COMPREHENSIVE EXAMINATIONS ARE TO BE WRITTEN*

By R. L. SWEIGERT

Georgia School of Technology

This subject implies that the question of whether there should be comprehensive examinations or not, has been settled in the affirmative.

In Bulletin No. 28 (1936) from the Carnegie Foundation for the Advancement of Teaching, it was stated that the central problems of education are three in number.

These are:

1. Setting up generally accepted standards of achievement.
2. Devising methods of measuring this achievement and of holding students to performance.
3. Introducing flexibility in educational offerings so that each individual may receive the education from which he is able to derive the greatest benefit.

I believe that proper comprehensive examinations can contribute to the working out of these problems in engineering education. In so far as the results from such examinations contribute to guidance they aid in problem number 3 above. They certainly form at least part of the solution to problem number 2. Number 1 must be determined before the examinations themselves can be built. With this brief statement, the point will be accepted that comprehensive examinations are desirable.

In past discussions covering comprehensive examinations three levels of achievement have been noted: one at the level of the entering freshmen, one at the level of the end of the sophomore year, and one at the level of the senior year. On the basis of subject matter the first would cover high school work, the second, pre-engineering work, and the third, professional engineering work. In order to answer the question, "In what fields should comprehensive examinations be written?" it must be decided what subject matter should be covered on the basis of the above three levels of achievement. My brief discussion is based upon the premise that whatever is done in connection with the development of compre-

* Presented at the Conference on Comprehensive Examinations, at the 46th Annual Meeting, S. P. E. E., A. & M. College of Texas, June 27–30, 1938.

hensive examinations must aid in the educational process in engineering education.

The engineering school has no control over the preparatory school experiences of young people who decide to follow engineering profession. Control of the situation starts when a prospective student comes to the engineering institution. At this stage the problem is one of selection, guidance, placement, and prediction of success. I do not see any benefit to the student or to the school in attempting to build up and introduce new comprehensive examinations at this stage. Dean Sackett pointed out at the Madison meeting that mathematics tests alone seemed to have as high a predictive value as a whole battery of tests. Since considerable time and effort have already been put upon such tests as the Iowa tests and the Coöperative tests, since these are available and are being worked upon by experts, and since they will serve the purposes in giving examinations at this stage, I see no necessity or advantage to be gained in attempting to do anything on new comprehensive examinations. Those familiar with the work of construction of the examinations themselves and then the later work of proving their reliability and validity will know that time can be more profitably spent on the second and third levels of achievement previously mentioned.

In the past records of the society there are discussions of the comprehensive examinations used at Maine and at Lehigh between the sophomore and junior years. Rather than attempt to evaluate these regardless of their possible merit, I am going to risk a brief general discussion based largely upon personal observation and opinion.

Before the fields for sophomore comprehensive examinations are given, it must be known what foundation of subject matter the embryo engineer should have. Such a listing may be subject to argument but nevertheless an attempt will be made to make such a list. In giving such a list only those items will be included which seem to have considerable weight in the student's future success in engineering education, or will point out weaknesses for which remedial work may advantageously be done. I believe that the first three mentioned will be accepted by almost everyone. These are: mathematics, physics, and chemistry. I believe one examination in English should be included for diagnostic purposes. Those students not reaching a satisfactory level of performance in English should be required to improve their level during the last two years. In addition I am in favor of one general comprehensive examination in which mathematics and the other sciences would be tied together. I feel that some integration should be brought about. There might be some question raised concerning the inclusion of an examination

in general engineering drawing. There might possibly be one in this field. I would say that such an examination if properly prepared might contribute as a measure of expression, imagination, and visualization. It appears to me that the purpose of such an examination would likely be diagnostic in character along with the English examination. The four examinations on science would be all important in measuring the level of scientific achievement suitable for engineering success.

One of the prime purposes of senior or final comprehensive examinations at the end of the professional training, along with measuring achievement, is to produce integration. Emphasis is still largely on differentiation. In order to produce integration I am in favor of only one general comprehensive examination for whatever field of engineering the student has been studying. This would mean a comprehensive examination in mechanical engineering, electrical engineering, and so forth.

For my own purpose I have set up three classroom objectives for professional courses. These are:

1. The building up of a satisfactory technical vocabulary.
2. The development of an understanding of fundamentals.
3. The development of the ability of the student to grasp the essentials of a new situation and work out a satisfactory solution.

A satisfactory solution should include social, economic, and production aspects of the problem as well as the technical phases. I believe that a student who has successfully developed through the three phases just mentioned will be prepared for industry in so far as the professional school can prepare him.

Since the third above is the ultimate objective, the comprehensive examination should bring out the extent of its attainment on the part of the student. Such an examination, it appears to me, involves a series of problems, each one of which is comprehensive in character. These problems could be so selected that there could be a series for each functional aspect of engineering including sales, installation and construction, production, design, and research.

The following is an illustration of such a problem. It is a real industrial problem, not a fictitious one. I believe a sufficiently large number of such problems could be gathered from industry. In the case under consideration, large steel I-beams were being heat-treated on a production basis. They were being quenched in oil. The control of the oil temperature became the problem since all the beams had to be treated alike. The mass of the beams, the temperatures, and the length of time for production were known.

The solution would have to be worked out from that data. Without going into details, such a problem involves heat capacities, heat transfer, fluid mechanics, thermodynamics, cooling or refrigeration, power, production, production costs, and a comparison of the initial cost and operating costs of various combinations of equipment that might be used. The student would be confronted with both the technical and the economic aspects of the problem. Incidentally in such a problem the actual industrial solution would be at hand. The final solution might be given as a real report. Thus English would also be included as a part of the examination.

By inclusion of the functional aspects of engineering in the comprehensive examination, the results would be usable in giving better guidance to students.

In conclusion I might say I have mentioned slightly more detail concerning the final comprehensive examination than the others because of less attention having been given to that level of achievement testing. It seems to me that there has been a marking of time in recent years in comprehensive examinations in so far as any coöperative effort is concerned. I hope there may be some crystallization of a program in the near future in which a number of institutions can do some effective coöperative work in producing suitable type comprehensive examinations.

REPORT ON COMPREHENSIVE EXAMINATIONS*

By PAUL CLOKE

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Examinations in the modern American college and university follow, for the most part, the traditional pattern which was formed from the old school master idea of early American attempts at education. The comprehensive or general examination is an attempt to remedy some of the obvious faults of the existing situation, and particularly to set up a system of greater efficiency.

Most Land Grant colleges and universities face admission problems which do not exist in many private institutions. In general, graduates of high schools in a given state are admitted to the State College and University. The consequence is that several freshmen, and even sophomores, find themselves either misfits or unable to continue. Usually it is difficult to convince such students and their parents that it is unwise to continue, at least without further preparation. A properly designed general examination covering

* Presented at the Conference on Comprehensive Examinations, at the 46th Annual Meeting, S. P. E. E., A. & M. College of Texas, June 27–30, 1938.

the sciences and mathematics is apt to help tremendously in guidance efforts.

In many European educational institutions of learning, the general examination is traditional as are our periodic tests and examinations. The American student has gotten into the habit of being checked at frequent intervals and does not recognize the deeper significance of the real meaning of education. The comprehensive examination helps the student to a fuller recognition of the coördination of various courses. This is all the more pertinent in view of the growing sentiment in favor of greater coördination of various courses of study. It should be clear, therefore, that a comprehensive examination is one in which a given question calls for coördinated knowledge in several fields such as physics, chemistry, and mathematics, or one in which an engineering problem would call for technical knowledge, as well as a knowledge of economics. Unless the faculty have a proper conception of the nature of such an examination and recognize its potentialities, dissatisfaction is almost sure to result.

In general, in a well organized system of examinations, administrative procedures are more satisfactory and more readily carried out. A student may fail a test or a subject which may mean very little in so far as his ultimate success is concerned. It is scarcely conceivable, however, that he is prepared to proceed with junior year work if he has not a comprehensive knowledge in the sense stated, of the sciences and mathematics; or that he is prepared to graduate if he has not a comprehensive view, in the sense explained, of his major field of study. After all, our job is to develop leaders. Experience with properly designed, comprehensive examinations shows beyond all shadow of doubt who the students are who have gained the fuller and more complete viewpoint in their studies. If it is true, as has been stated, that an education is essential for success in engineering today, and that the high ranking students stand the best chance of success, then the comprehensive examination is fully justified and substantiated.

No detailed explanation of comprehensive examinations and their technique, or of comparisons of results with formal and comprehensive examinations is given in this report as these have all been fully discussed in previous conventions and published in the Journal. Realizing that the development of personality is a matter that transcends all testing procedures, an attempt has been made in this report to indicate the larger viewpoint of a worthwhile educational objective. Criticism was made at previous conventions that this aspect was neglected.

CONTROL AND STABILIZATION OF ENROLLMENT*

By GEORGE B. CURTIS

Associate Dean and Registrar

AND

BRADLEY STOUGHTON

Dean, College of Engineering, Lehigh University

When the number of students desiring to study at a college is greater than the number which the college will accommodate, either because of arbitrary limitations set up by the Trustees or for any other reason, the problem of control of enrollment resolves itself into the adoption of a procedure whereby the most likely candidates will be selected from those applying. There is a wide-spread opinion, however, that the best "raw material" is not determined by means of scholastic tests alone. A Committee on Stabilization of one school writes:

> We should aim to admit as high a proportion as possible of men potentially qualified to become leaders in the careers for which we offer preparation. To this end we should give weight not solely to scholastic capacity, but also to personal qualities making for all-round effectiveness, such as imagination, adaptability, resourcefulness, dependability and cooperativeness.

And the Dean of another school says:

> A careful study of the correlations between the various entrance requirements and work in college afterwards has led us to the conclusion that, if we can get a fair rating of the man's performance in his preparatory school, that is perhaps the most significant of all sources of prediction.

With this conclusion many experienced college educators find themselves in agreement. It has the advantage of serving as a guide not only for admittance but also for probability of successful continuance, both of which have bearing on total enrollment. But, in an engineering college, the total enrollment in each class is only a portion of the problem: Consideration must also be given to the number of students enrolled in each of the departments, such as

* Presented at the Conference on Orientation at the 46th Annual Meeting, S. P. E. E., A. & M. College of Texas, June 27–30, 1938.

chemical, industrial, electrical, etc. There are wide fluctuations between the maximum and minimum number of students in each of several departments over a period of years. If a department is staffed and equipped to handle effectively a large number of students, which proves to be a peak over a number of years, it becomes a financial burden in a period of declining registration. When "peak loads" occur successively in several departments, the result may be serious. For an engineering school to operate most efficiently in the economic sense, it is obvious that all departments must be stabilized, or else must change in enrollment only slowly, and that teaching staffs must be ruthlessly cut as the number of students decreases. This latter is virtually and practically impossible. The effect of uncontrolled registration fluctuations at a large engineering school between the years 1922 and 1931 respectively, is shown by the following figures:

	Total Number of Students	Total Number of Teachers	Proportion
1922	3,180	391	1 to 8
1931	3,188	588	1 to 5½

This result is due in part to expansion of the research program and in part to fluctuations in student enrollment department peaks.

Control of Enrollment Department by Department.—Control of the number of students in each of several departments may be effected in either of two ways:

A. Admitting to the freshman class only a limited number of students aiming at each of the several departments, or else

B. Controlling the total number admitted to the freshman class, and limiting the number admitted later to each of the departments.

Advantages of Method A

Wisely or unwisely, at least 75 per cent of all students entering college have already selected the curriculum which they intend to pursue. Therefore, their admittance in numbers limited to departmental facilities will approximately control departmental enrollments and, at the same time, allow students to continue their college course according to their first choice. Only a small percentage change their minds during the freshman and sophomore years in any event.

They are stimulated to serious study from the start because they are working for the profession of their choice, and they continue to do so as long as they desire, unless, and until, they are overcome by scholastic difficulties.

This method assures the probability of there being no curricula which find themselves with very few or no students in the sophomore year, and lessens the likelihood of many being denied permission to continue in the curriculum of their choice, some of whom may leave the college altogether.

If a student desires to change his curriculum later than entrance, he may do so if he can gain admittance to the curriculum of his new choice. Ordinarily this can be provided for.

Advantages of Method B

Deferring the choice for a year or two of college experience enables the students to choose more wisely and also enables a department to select students who have indicated an aptitude for the work of the curriculum and for the profession.

Admitting to the freshman class according to departmental limitations does not give as good an opportunity to select only the very best candidates. Furthermore, unless there is a large excess of candidates over the freshman class quota, either the quota will not be filled or else some students of inferior grade will be admitted.

There are more scholastic difficulties in the cases of students who have chosen their curricula unwisely. Most students (and their parents) are loathe to forego the choice of a curriculum, or to change a curriculum however unwisely chosen, on the basis of experience and predictions which, to a neutral person or to an experienced faculty adviser, are more cogent than mere "stick-at-it-iveness."

A student who is not yet ready to make a decision is forced by method *A* to do so before being admitted to the freshman class.

A student entering by method *A* may be "stuck" in a curriculum which later he does not like, and may even change to another college in consequence.

Two considerations have made colleges cautious about the use of method *A*, namely: The danger of falling off in the number of applicants, or else the danger of applicants not entering after applying. And, second, because the reputation of a college is in part dependent on the quality of its graduates, which in turn is in part dependent on the quality of the entrants. To lessen the efficiency of wise choice of the latter for the sake of allowing students to follow selections of curricula which most of them made admittedly on insufficient knowledge, is bad for both students and college. Statistics show that nearly half the students either leave college voluntarily or else "flunk out" of the courses which they have chosen for themselves either with or without advice. Some

figures relating to this are given in the following table. These figures were compiled for the last three available years at Lehigh University, College of Engineering, and are probably somewhere nearly representative of other engineering schools.

	Class of 1935		Class of 1936		Class of 1937	
Total number of entering freshman engineers	283		224		213	
Total number graduating on time	118	42%	109	48%	96	45%
Balance—not graduating on time	165		115		117	
Made up as follows: Graduated late*	47	16%	29	14%	36	17%
Balance—not graduating at all	118	42%	86	38%	81	38%
Of these: Withdrew, good scholarship†	16		11		5	
Withdrew, poor scholarship‡	60		49		37	
Flunked out, or equivalent	42		26		39	

* Including a few who graduated late in the College of Arts or Business Administration.

† Average grade of 2.00 or better on a scale of 4.00.

‡ Average grade of less than 2.00.

Parenthetically, it is a matter of common knowledge which has been supported more than once by published data, that not many more than half of those who successfully complete their engineering course follow in life the branch of the profession for which they have trained themselves.

On the other hand, method *B* imposes upon the college some danger of bringing upon itself such a situation as that incurred at Yale University, as mentioned later in this paper.

Perhaps a compromise between the two methods, providing for a maximum and optimum number for each curriculum under method *A* with provision through a comprehensive examination for elimination and selection under method *B*, is the golden mean.

Methods of Control and Stabilization of Enrollment

A Committee on Stabilization at the Massachusetts Institute of Technology has completed the first comprehensive plan of stabilization of all courses of which we have knowledge. This Committee divides the undergraduate courses into three groups:

1. Courses or departments which are crowded (perhaps too crowded for their own good);

2. Courses or departments which are crowded, but which should be dealt with not by restricting registration, but by utilizing existing staff facilities to better advantage;

3. Courses or departments which are uncrowded and which have no probability of ever being loaded to capacity. These are sub-divided into two groups: (*a*) those which should be retained as a matter of policy, prestige, public good, etc., and (*b*) those which do not seem to justify their existence.

In brief, the plan proposed by this Committee involves admitting students from the uniform freshman year to the individual curricula without stabilization for the first semester of the sophomore year; allowing the Head of a course to examine his candidates through this first semester, and then stabilizing the courses according to a pre-determined number for the second semester. Upper and lower limits are set for each course, whether crowded or not, with the object of protecting every course from an influx of students denied registration elsewhere. This stabilization may result in some students being denied admission to any course which they are willing to enter; such students are allowed to remain unclassified for not more than two successive semesters, during which time they may improve their standing so as to be acceptable upon petition to some course of their choice. The selection of quotas is not based alone on general scholastic standing, nor even on grades in significant subjects, but is left to the discretion of the Head of the course, provided that such selection does not reduce the total sophomore enrollment of the course below the lower limit pre-determined for the course.

The experience of an important engineering college in the middle west is interesting and enlightening: Here they have four engineering departments, namely, chemical, civil, electrical, and mechanical. The mechanical and chemical courses are heavily overcrowded. In the chemical department they think they may be able to keep out the worst students by insisting that none be allowed to enter chemical engineering in the sophomore year if his grades in chemistry during the freshman year have been unsatisfactory. No yardstick has been found yet for limitations in mechanical and other engineering. Scholarship alone is thought to be an unsuitable criterion, because students who have made very ordinary records during their first two years have been known to distinguish themselves during the latter part of their course. This checks definitely with experience at other colleges * and gives added potency to the thought that a combination of a Sophomore Comprehensive Engineering Examination with the scholastic grades of the freshman and sophomore years, which

* See "Sophomore Comprehensive Examinations at Lehigh University," by Charles W. Simmons and Bradley Stoughton, JOURNAL OF ENGINEERING EDUCATION, Vol. XXVIII, January, 1938.

seems to be a 97 per cent indication of student engineering aptitude for the junior and senior years,* is applicable as a yardstick for admission to crowded curricula, when used with discretion and understanding. This point will be discussed later in this paper.

The problem at Yale is a difficult one because it has a limited enrollment in the freshman year, with distribution thereafter to Yale College, the Sheffield Scientific School, and the School of Engineering. The bulk of the students have been going to the College, leaving the Scientific and Engineering School with an inadequate supply. Attempts were made to meet this situation by selecting men for the freshman class with a bias in favor of those who showed aptitude and interest in scientific and engineering work. This is somewhat in line with the method *A* outlined above. It did not seem to work very successfully and in general it was thought that the best results were secured by trying to select from all applicants the most promising students, irrespective of any expression of opinion, given or implied, as to what particular line of work they intended to follow in college.

Lehigh University has had to face the problem of determining a limit to the number of new students to be admitted each autumn and to the still greater problem of providing a proper distribution in its various divisions to the end that the facilities of one division might not be crowded while the staff of another division might have few students to teach. The Board of Trustees, some years ago, fixed the limit enrollment of the University as 1500 paying students; and the number of entering students during the past two years has been such that the whole question of control and stabilization of enrollment has received serious consideration at the hands of various university authorities and committees.

Lehigh University is divided into three colleges: The College of Arts and Science, the College of Business Administration, and the College of Engineering. The College of Engineering has been sub-divided into what for practical purposes amounts to eight engineering curricula. The problem of the admissions officer is to provide the proper proportion of students for each of the three colleges, and, within the College of Engineering, for each of the eight engineering curricula. While desiring to retain the uniform freshman year for the College of Engineering and as great freedom as may be expedient in the change of curriculum on the part of a student, once admitted, the University has been faced with the problem of avoiding a repetition of the experience of one large eastern institution which accepted students in the freshman

* Although neither one alone is sufficiently indicative to be a criterion for mandatory action in strict justice to the students.

year without classification as to individual choice on the part of the student, in the expectation that the distribution of choices on the part of the students admitted would fall into groupings concordant with the facilities of the university. The experience of the arrangement adopted led to a considerable lack of balance as between the divisions of that university. Our problem is, if possible, to avoid a similar experience.

Our general problem can be divided into several subsidiary problems. First of these problems with us has been to determine what total enrollment will produce the equivalent of 1500 full-tuition students. Investigation disclosed that there are approximately 198 non-paying students which must be added to the 1500 paying students, giving a total of 1698 students as the average enrollment per semester. The enrollment in the second semester is always less than that of the first semester. As careful an estimate as it is possible to make indicates that we must count upon a 7 per cent smaller enrollment in the second semester than in the first. Accordingly, we find that the total first semester enrollment may be 1760 students.

Setting up the limit of 1500, the Board of Trustees indicated a desirable relationship between the three colleges as follows: Arts and Science, 300; Business Administration, 300; Engineering, 900. This represents a 1–1–3 ratio. Applying this ratio to the total enrollment of 1760 students, we have as our objective 350 Arts students, 350 Business Administration students, and 1060 students in the College of Engineering. In actual practice, over the past decade, the growth of the University has not been as rapid in the non-engineering branches of the University as in engineering. In fact, the College of Engineering has grown beyond the figure of 1060, whereas the College of Arts and Science, and Business Administration have fallen under the aggregate assigned to them. Since many students have chosen to enter the College of Business Administration rather than the College of Arts and Science with a major in economics, and since all but three of the ten year-courses taken by freshmen and sophomores in the College of Business Administration are Arts and Science subjects, and since also in Business Administration in the junior and senior years there are liberal electives in Arts and Science, and since, further, many liberal arts students take work in the field of economics, the Faculty has felt that the intent of the Board of Trustees would be more nearly met by accepting 700 non-engineering students, even though this should mean an excess beyond the 350 assigned to the College of Business Administration. A part of the problem of the admissions officers has therefore been to secure 700 non-engineering students and to limit the College of Engineering to its quota of

1060 students, but at the same time to attain to the total of 1760 students for the University as a whole.

The second problem has been to determine the number of freshmen to be admitted in order that over a period of four years, the enrollment might reach and remain stabilized at 1760 students. If each student who enters the University in a particular curriculum remained throughout his four years and graduated in that curriculum, the problem would be very simple. We would accept 440 students each year, distributed in the proper manner among the several divisions of the University, and then promptly dismiss the subject of stabilization and control from our minds. But, unfortunately, students have a way of changing their interests and of dropping by the wayside.

In attacking this problem of student persistence from the time of entrance until the time of leaving, we can consider them as first-year students, second-year students, third-year students, fourth-year students, and fifth-year students. In other words, we can consider them according to their classification as social sophomores, social juniors, social seniors, and fifth-year men. On the other hand, we can take their academic classification according as they have attained sophomore standing, junior standing, and senior standing. From the point of view of the admissions officer, probably the first method of classification is the more satisfactory in that the loss from the first to the second, the second to the third, the third to the fourth, and the fourth to the fifth year can be more readily computed and followed. We think, however, that probably no registrar's office has ever kept data on the first basis but has instead normally followed the faculty regulations for the classification of students as academic seniors on the basis of the number of hours passed, academic juniors in the same manner, and in like manner, sophomores and freshmen. Accordingly, some sort of compromise has to be made between the two systems. At Lehigh we have, for many years, kept a record each autumn of the number of men entering the freshman class, of the number of freshman "repeaters," of students with sophomore academic standing, junior academic standing, and senior academic standing. It has seemed simplest to us to throw these "freshman repeaters," or second-year men, into the general category of sophomores and to retain in the sophomore group the third-year men who have failed to attain junior standing. The juniors and seniors have been classified strictly according to their academic standing. With the sophomore class swelled, therefore, by the freshman repeaters and the third-year men who have failed to attain junior standing, this group is obviously the largest "class" in the University each year.

As stated above, statistics have been made each autumn over a

period of many years according to these classifications. The percentage of students in each group as a ratio of the preceding period has been computed and an average over a period of years worked out. These ratios have been worked out by two different officers of the University covering two different periods, with surprisingly close results. These have been as follows:

	Fresh.	Soph.	Jr.	Sr.
Ratio for the years 1928–1936, inclusive, omitting unusually low figures	100	110	71	63
Ratio for the years 1928–1936, inclusive, omitting unusually high figures	100	105	67	54
Ratio for 1931–1938, inclusive	100	115	73	65
Ratio for 1931–1938, exclusive of class of 1936	100	112	71	63

The second of these ratios, namely, 100–105–67–54, was chosen as representing a more conservative basis for maintaining the desired enrollment. With this set of figures we find that we need a freshman class of 540 students to produce a total enrollment of 1760:

$$1.00 + 1.05 + 0.67 + 0.54 = 3.26,$$
$$1760 \div 3.26 = 540.$$

We can assume then that a freshman class of 540 students year by year will give us approximately the 1760 students desired.

But we must recognize here that while a class of 540 freshmen will produce an enrollment of 1760 students, when it comes to distributing these freshmen among our three colleges, we cannot be certain that the ratios of persistence which have held in the past for the University as a whole will hold for the separate colleges. We know that our figures include in the College of Arts and Science and in the College of Business Administration students who have transferred to that college from the College of Engineering and who did not enter those colleges as freshmen. Accordingly, if we cut down on our enrollment in the College of Engineering and increase the number of students entering in Arts and Science and Business Administration, we can by no means be certain that these ratios of persistence will still be valid. We do not have available, and cannot readily obtain, the necessary statistical data to show the ratio of persistence of students entering as freshmen in Arts and Science, in Business Administration, and in Engineering, respectively, nor the number of students who have transferred from one college to another, but have still carried on. Such statistical data might be very helpful but would be too costly to assemble.

As a practical starting point, however, we can take the average

over a six-year period (1932 to 1937) of students entering the three colleges on a percentage basis. Thus we find that over this six-year period, 12 per cent of our entering freshmen have entered the College of Arts and Science, 18 per cent have entered Business Administration, and 70 per cent have entered Engineering. Dividing our class of 540 on this ratio, we would have 65–97–378 as a typical entering class. In undertaking to set up a quota for the three colleges for an entering class of freshmen, we can therefore tentatively set this figure and undertake to predict, if possible, what will happen to our total enrollment on this basis.

Realizing that there is an interchange between the colleges, and particularly a drift from engineering to the two non-engineering colleges, we can set up ratios of persistence for the three colleges separately. This is not to say that these ratios would exist at all for any one college if the other two colleges were not present on the campus, but simply to provide us with some basis upon which to theorize. Omitting the class entering in 1932 (the class of 1936) because it was unusually small, we find we had the following ratios for the years 1931 to 1937 inclusive:

	Fresh.	Soph.	Jr.	Sr.
Arts and Science	100	119	76	71
Business Administration	100	134	84	55
Engineering	100	96	55	50

If, now, these ratios are balanced for the hypothetical class of 540 students, distributed as 65 in Arts and Science, 97 in Business Administration, and 378 in Engineering, we should be able to compute the probable number of freshmen, sophomores, juniors, and seniors distributed among the College of Arts and Science, Business Administration, and Engineering, respectively. These ratios and numbers work out as follows:

	Fresh.		Soph.		Jr.		Sr.		Non-Eng.	Total
	Per cent	No.	Per cent	No.	Per cent	No.	Per cent	No.		
Arts	100	65	119	77	76	49	71	42	233	611
Business	100	97	135	131	84	81	55	69	378	
Engineering	100	378	96	363	55	208	50	188		1137
Totals		540		571		338		299		1748
Total Univ.	100	540	105	567	67	362	54	291		1760
+ Differences between the two types − of calculation				+4		−24		+8		−12

The curious thing about this computation is that we find ourselves short 24 juniors, that we have 8 seniors more than we would expect, and that we have an aggregate of 1748 students, whereas we started out with a figure of 1760 students. In other words, based on the average experience of these three colleges taken independently, we do not arrive at the same maximum figure as when we take the ratios for the University as a whole. Of course the total of non-engineering students is only 611, whereas the desired total is 700, and the total number of engineers is 1137, whereas the desired total is 1060.

If, then, we try to readjust somewhat the quotas of the colleges for the freshman year, we make out a further theoretical table of enrollment. Let us assume that we can increase the enrollment in Business Administration to 115, that the enrollment in Arts and Science cannot readily be increased, and that we reduce the enrollment in Engineering to 360 freshmen, leaving the total 540 as before. Again applying the ratios, we secure the following results:

	Fresh.		Soph.		Jr.		Sr.		Non-Eng.	Total
	Per cent	No.	Per cent	No.	Per cent	No.	Per cent	No.		
Arts	100	65	119	77	76	49	71	42	233	663
Business	100	115	135	155	84	97	55	63	430	
Engineering	100	360	96	346	55	198	50	180		1084
Totals		540		578		344		285		1747
Total Univ.	100	540	105	567	67	362	54	291		1760
± Differences				+11		−18		−26		−13

It will be noticed from this table that we have secured an enrollment of 663 non-engineering students and have reduced the engineering enrollment to 1084, giving us a total of 1747,—13 short of the desired 1760.

It would appear, therefore, that since the enrollment of 1760 students is needed for budgetary reasons, it will not do to limit our freshman class to 540 students and that we should retain a quota of 378 engineering students for the entering class. If we retain this figure, we produce the following table:

	Fresh.		Soph.		Jr.		Sr.		Non-Eng.	Total
	Per cent	No.	Per cent	No.	Per cent	No.	Per cent	No.		
Arts	100	65	119	77	76	49	71	42	233	663
Business	100	115	135	155	84	97	55	63	430	
Engineering	100	378	96	363	55	208	50	189		1138
Totals		558		595		354		294		1801

This gives us an apparent excess of 41 students, but since it is not at all certain that the aggregate number of Arts and Science and Business Administration freshmen will be 180 students, we retain a margin of safety to the end that our aggregate enrollment may be 1760 students. As experience dictates, we can later reduce the number of engineering freshmen who are accepted and can increase the number of Arts and Business students placed on the theoretical quota. In the meantime, it is fairly obvious that we should accept all Arts and Science students and all Business Administration students who adequately meet the requirements for admission.

We come now to the more difficult problem of dividing our quota of freshman engineers among the eight curricula. In undertaking to do this, we are at once faced with the problem that three of our curricula, namely, Chemistry, Industrial Engineering, and Mechanical Engineering, are quite definitely overcrowded at the present time and that, on the other hand, certain other curricula could quite definitely take care of as many applicants for those curricula as are likely to present themselves for admission. We feel that it is socially undesirable to undertake to induce young men to enter those curricula which prepare for careers in fields in which there appears to be no present demand for engineering graduates. We feel rather definitely that we have to face the fact that possibly some engineering fields have rather definitely passed into "horse and buggy" stages of development and that we must be prepared to transform our staff and plan to take care of the greater demand in other fields. At the same time, we know that first one curriculum and then another becomes popular throughout the country in its appeal to young men. The problem of avoiding over-development in those fields is a particularly difficult one.

The problem is further complicated by the fact that each curriculum interlocks with every other curriculum, that the Department of Chemistry, for example, will teach some students, other

than freshmen, in Sanitary Engineering, Engineering Physics, Mining Engineering, and particularly Metallurgical Engineering. Likewise, the Department of Metallurgical Engineering, besides teaching metallurgical engineers, will have a considerable number of courses taken by chemical engineers, and others. A decrease in the number of chemical engineering students would at once reduce the teaching load in the Department of Metallurgical Engineering. This, in turn, will permit the Department of Metallurgical Engineering to increase the number of students specializing in metallurgical engineering. In other words, the problem of adjusting the number of "home room" students and the number of "foreign" students taught by any particular department becomes a problem where the answer to the first problem must be given before the answer to the second problem can be obtained, and vice versa. With a view to giving us a picture of what is involved in this complex situation, we prepared, for the first semester of the past academic year, tables showing the number of students in each course, divided according to the college and curriculum of the students taking the courses. We have done this for the departments which seem to be approaching or have exceeded the facilities thereof. Tables showing the courses in these departments and the curriculum of the students taking those courses is appended.

From this table it is obvious that the Department of Chemistry is teaching 1581 semester hours of work to its own students, exclusive of freshmen. If fewer chemical engineers are accepted, the teaching and equipment load on the department will be materially reduced. This, in turn, as shown by the table for the Department of Metallurgy, will reduce the load on the Department of Metallurgical Engineering. Such a reduction in the number of chemists taught by that department would, presumably, permit an increase in the number of metallurgical engineering students. These tables as presented are merely illustrative of the method of procedure in undertaking to determine the optimum quotas for each curriculum, keeping always in mind the effects of increasing or reducing the number of students in a given curriculum on those departments which act as "service departments" for that curriculum. These tables have enabled us to discover quite readily which curricula can accept more students without taxing the teaching facilities of the department, if applicants present themselves.

With these data and a table of distribution of students by curricula for each of the four years obtained both by theoretical computation from persistence ratios and actual registrations over a period of years, it has been possible to set up maximum and opti-

mum figures for each curriculum for the guidance of the officer of admissions.

The Use of a Comprehensive Examination for Limitation of Enrollment

It is, we believe, generally admitted that scholastic grades alone are not adequate to determine a student's aptitude for any branch of engineering except only in the very top and very bottom brackets. Scholastic grades may be a guide to intelligence and/or industry (to a limited extent) but give little indication as to other important personal qualities listed in the quotation on page 1 of this paper. Even grades in significant subjects, such as freshman chemistry marks, for example, as an indication of aptitude for chemical engineering, have not proved to be always sufficiently definite as a prediction to enable mandatory action to be taken with complete justice to a student. A comprehensive examination at the end of the sophomore year introduces an entirely new phase of the situation, throwing new light on a student's aptitudes. That a comprehensive examination is in a different category from mere scholastic grades is indicated by the circumstances discussed in the paper on this subject published last year and already referred to herein, namely, that scholastic grades alone are not a sure indication of promise, nor are the grades in the comprehensive examination, but a combination of the two proves to be adequate in 97 per cent of the cases.

A properly constituted comprehensive examination is "intended to test the student's ability to apply information of a basic character to engineering problems rather than to state facts from memory." The examination at Lehigh is made up of 88 questions in the fields of chemistry, mathematics, and physics, formulated by the eight engineering departments and approved by the service departments mentioned and by the committee. "Thus, for example, the Electrical Engineering Department has questions in chemistry relating to electrodeposition, or the Chemical Engineering Department asks for the mathematical solution of an equation used in the study of filtration."

If we admit the probability that the comprehensive examination, in combination with the scholastic grades of the first two years, indicates a student's ability or inability to continue in the School of Engineering, then it seems evident that there may be a possibility that the answers to the comprehensive examination questions, if studied in detail and comparatively one to another, will indicate ability to apply basic subjects to chemical problems, or to mechanical problems, or to electrical problems, etc., and thus

CHEMISTRY

	Chem. 1 (2)	Chem. 2 (2)	Chem. 3 (2)	Chem. 6 (3)	Chem. 11 (2)	Chem. 12 (1)	Chem. 13 (2)	Chem. 14 (1)	Chem. 30 (3)	Chem. 33 (3)	Chem. 36 (2)	Chem. 41 (1)	Chem. 44 (1)	Chem. 48 (1)	Chem. 134 (3	Chem. 144 (1	Chem. 150 (3	Chem. 155 (1)	Chem. 158 (2)	Chem. 165 (2)	Chem. 169 (1)	Chem. 171 (2)	Chem. 180 (3)	Chem. 190 (3)	Chem. 193 (2)	Chem. 296 (3)	Total	Total Excluding Freshmen
Arts	31	5	4	13	29	5	4	..	12	1	..	14	1	..	..	..	11	..	..	..	..	..	..	1	..	..	280	129
Bus.	..	10	..	..	..	10	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	33	3
Ch.E.	68	..	43	64	69	..	41	..	78	..	..	85	..	..	14	13	66	13	36	66	1	23	47	47	47	1	1835	1393
Chem.	1	..	5	4	1	..	5	..	6	..	..	6	..	..	5	4	3	6	10	..	2	11	3	14	14	..	212	188
C.E.	12	..	1	..	14	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	56	..
S.E.	3	..	..	..	3	..	..	..	1	..	..	1	..	..	..	..	1	..	..	..	..	..	..	..	..	..	19	7
E.E.	30	..	5	..	30	..	5	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	140	..
E.P.	6	..	2	11	..	..	2	..	1	..	..	1	..	..	..	..	1	..	..	..	..	..	..	..	..	..	60	40
I.E.	52	..	6	..	52	..	6	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	232	..
M.E.	75	..	7	..	73	..	7	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	324	..
Met.E.	26	..	7	30	24	..	7	..	..	41	..	..	45	..	3	3	..	..	..	..	..	..	..	..	..	..	395	267
Min.E.	6	..	..	..	6	..	..	..	..	..	7	..	..	8	..	..	..	..	..	..	..	..	..	..	..	..	46	22
Grads.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Engr. 41	9	..	..	..	9	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	36	..
Total Wt.	638	30	160	366	620	15	156	..	294	126	14	107	46	8	44	20	249	19	92	132	3	68	150	186	122	3	3668	2049
No.	319	15	80	122	310	15	78	..	98	42	7	107	46	8	22	20	83	19	46	66	3	34	50	62	61	1	1713	....

METALLURGY

	Met. 1 (2)	Met. 3 (2)	Met. 5 (1)	Met. 21 (2)	Met. 23 (2)	Met. 33 (1)	Met. 81 (1)	Met. 83 (1)	Met. 90 (2)	Met. 125 (2)	Met. 131 (3)	Met. 132 (2)	Met. 135 (1)	Met. 137 (1)	Met. 153 (1)	Met. 154 (1)	Met. 163 (1)	Met. 176 (2)	Met. 201 (6)	Met. 202 (3)	Total—Wt.
Arts	2	1	....	1	2	....	2	....	....	....	2	....	....	2	....	....	....	1	....	....	24
Bus.	1	....	....	3	1	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	11
Ch.E.	1	1	....	....	40	2	....	35	....	....	....	....	....	....	....	....	....	....	....	....	121
Chem.	....	1	....	....	5	....	....	4	....	....	....	....	....	....	....	....	....	....	....	....	16
C.E.	....	....	....	1	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	3
S.E.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
E.E.	....	2	....	32	....	....	33	....	....	2	....	....	1	....	....	....	....	....	....	....	106
E.P.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
I.E.	....	1	....	22	....	1	25	1	....	....	....	....	....	....	....	....	....	....	....	....	73
M.E.	....	....	1	....	....	17	6	....	....	....	....	....	....	....	....	....	....	....	....	....	24
Met.E.	44	11	....	7	....	3	2	....	....	31	12	12	30	12	8	4	11	1	....	....	318
Min.E.	....	1	....	1	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	5
Grads.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Total Wt.	96	36	1	134	96	24	70	40	....	66	42	24	31	14	8	4	11	4	....	....	701
No.	48	18	1	67	48	24	70	40	....	33	14	12	31	14	8	4	11	2	....	....	445

	M.E. 1 (3)	M.E. 2 (3)	M.E. 9 (1)	M.E. 19 (1)	M.E. 21 (1)	M.E. 22 (3)	M.E. 29 (3)	M.E. 31 (3)	M.E. 33 (2)	M.E. 114 (2)	M.E. 117 (3)	M.E. 119 (3)	M.E. 121 (3)	M.E. 200 (3)	M.E. 203 (3)	M.E. 207 (3)	M.E. 211 (3)	I.E. 2 (3)	I.E. 9 (3)	I.E. 11 (3)	I.E. 200 (3)	Total—Wt.
Arts	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2	....	....	....	9
Bus.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	25	....	....	....	75
Ch.E.	1	....	2	....	....	....	4	....	....	....	....	....	....	....	....	....	....	....	....	....	....	17
Chem.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	3
C.E.	....	....	....	4	....	....	6	....	....	....	....	....	....	....	....	....	....	1	....	....	....	25
(S.E.)	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	.....
E.E.	1	2	....	....	30	31	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	132
E.P.	....	....	....	....	....	1	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	6
I.E.	49	54	1	....	40	....	1	....	45	....	3	1	....	....	....	....	....	2	47	23	1	674
M.E.	45	49	27	....	1	....	2	26	27	22	20	4	24	....	....	....	....	8	....	....	....	660
Met.E.	....	....	....	....	....	2	3	....	....	....	....	1	....	....	....	....	....	....	....	....	....	18
Min.E.	....	....	....	....	....	4	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	12
Grads.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	.....
Total Wt.	288	318	30	4	71	114	48	78	144	44	69	21	72	....	....	....	....	117	141	69	3	1631
No.	96	106	30	4	71	38	16	26	72	22	23	7	24	....	....	....	....	39	47	23	1	645

PHYSICS

	Phys. 12 (3)	Phys. 14 (3)	Phys. 22 (4)	Phys. 23 (4)	Phys. 24 (4)	Phys. 110 (1)	Phys. 122 (3)	Phys. 124 (3)	Phys. 150 (3)	Phys. 160 (3)	Phys. 162 (3)	Phys. 164 (2)	Phys. 211 (1)	Phys. 220 (3)	Phys. 222 (3)	Total—Wt.	Total Excluding Freshmen
Arts	20	7	2	1	....	...	...	...	1	1	...	...	...	...	...	99	91
Bus.	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	6	6
Ch.E.	...	...	62	9	68	...	...	...	...	1	1	...	...	...	...	562	314
Chem.	...	...	1	....	4	...	1	...	...	...	...	...	...	...	...	23	19
C.E.	...	...	9	15	3	...	...	...	...	...	...	...	...	...	...	108	72
(S.E.)	...	...	2	....	1	...	...	...	...	...	...	...	...	...	...	12	4
E.E.	...	...	20	7	25	34	...	2	1	...	...	...	...	...	...	251	171
E.P.	...	...	5	12	....	3	2	8	4	5	5	8	...	1	...	162	142
I.E.	...	...	33	55	10	...	...	...	...	...	...	...	...	...	...	392	260
M.E.	...	...	39	37	2	...	...	...	...	...	...	...	...	...	...	312	156
Met.E.	...	...	26	5	28	...	...	...	...	1	...	...	...	...	...	239	135
Min. E.	...	...	3	3	....	...	...	...	4	...	...	...	...	...	...	36	24
Grads.	...	...	....	....	....	...	...	...	...	...	...	...	...	...	...	....	.....
Engr. 41.	...	...	6	....	....	...	...	...	...	...	...	...	...	...	...	24	
Total Wt.	66	21	832	576	564	37	9	30	30	24	18	16	...	3	...	2226	1394
No.	22	7	208	144	141	37	3	10	10	8	6	8	...	1	...	608	.....

ELECTRICAL ENGINEERING

	E.E. 1 (1)	E.E. 4 (3)	E.E. 5 (1)	E.E. 11 (3)	E.E. 15 (1)	E.E. 23 (3)	E.E. 50 (2)	E.E. 51 (1)	E.E. 52 (2)	E.E. 53 (1)	E.E. 56 (2)	E.E. 57 (1)	E. E. 112 (3)	E.E. 113 (3)	E.E. 114 (3)	E.E. 121 (3)	Total—Wt.
Arts	...	...	...	...	...	...	1	1	...	...	....	...	...	...	...	...	3
Bus.	...	...	...	...	...	...	...	...	...	...	....	...	...	...	...	...	.....
Ch.E.	...	...	...	...	...	...	...	...	...	...	67	65	...	...	...	1	202
Chem.	...	...	...	...	...	...	...	...	...	...	1	1	...	...	...	...	3
C.E.	...	...	...	...	...	...	6	5	4	2	1	1	...	...	...	...	30
(S.E.)	...	...	...	...	...	...	...	...	...	...	1	1	...	...	...	...	3
E.E.	24	32	33	27	28	1	....	...	...	...	....	...	20	9	30	19	499
E.P.	...	...	...	...	...	...	1	1	...	...	....	...	...	...	...	4	15
I.E.	...	...	...	...	...	...	38	39	3	5	....	...	...	...	...	...	126
M.E.	...	...	...	...	...	...	4	4	15	15	....	...	...	...	...	...	57
Met.E.	...	...	...	...	...	...	23	23	2	...	2	2	...	...	...	...	79
Min.E.	...	...	...	...	...	...	7	7	...	...	....	...	...	...	...	1	24
Grads.	...	...	...	...	...	...	...	...	...	...	....	...	...	...	...	...	.....
Total Wt.	24	96	33	81	28	3	160	80	48	22	144	70	60	27	90	75	1041
No.	24	32	33	27	28	1	80	80	24	22	72	70	20	9	30	25	567

CIVIL ENGINEERING

	C.E. 1 (2)	C.E. 8 (4)	C.E. 9 (3)	C.E. 10 (1)	C.E. 16 (3)	C.E. 16a (2)	C.E. 32 (3)	C.E. 33 (3)	C.E. 118 (3)	C.E. 119 (3)	C.E. 122 (3)	C.E. 125 (3)	C.E. 128 (3)	Total	Total Excluding Freshmen
Arts	5	...	....	....	....	....	1	....	....	....	....	....	....	13	3
Bus.	1	...	....	....	1	....	....	....	....	....	....	1	....	8	6
Ch.E.	109	...	42	1	....	....	....	....	....	....	....	....	....	345	127
Chem.	7	...	....	....	....	....	....	....	....	....	....	....	....	14	....
C.E.	10	7	2	6	20	....	....	....	9	9	10	10	10	264	244
S.E.	3	...	1	....	....	1	....	....	....	....	....	....	....	11	5
E.E.	35	...	33	33	....	....	....	....	....	....	....	....	....	202	132
E.P.	8	...	....	1	....	....	....	....	....	....	....	....	....	17	1
I.E.	57	...	4	1	....	....	6	....	....	....	....	....	....	145	31
M.E.	80	...	....	....	....	....	26	14	....	....	....	....	....	280	120
Met.E.	33	...	31	24	....	....	....	....	....	....	....	....	....	183	117
Min.E.	6	...	9	5	....	....	....	....	....	....	....	....	....	44	32
Grads.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Engr. 41	10	...	....	....	....	....	....	....	....	....	....	....	....	20	....
Total Wt.	728	28	366	71	63	62	99	42	27	27	30	33	30	1546	....
No.	364	7	122	71	21	1	33	14	9	9	10	11	10	682	818

GEOLOGY

	Geol. 1 (4)	Geol. 1a (3)	Geol. 3 (2)	Geol. 6 (1)	Geol. 7 (2)	Geol. 8 (3)	Geol. 16 (3)	Geol. 111 (2)	Geol. 112 (2)	Geol. 114 (2)	Geol. 116 (1)	Total—Wt.
Arts	3	3	34	36	7	5	....	5	6	6	9	197
Bus.	....	....	2	2	....	....	70	....	....	....	....	216
Ch.E.	....	....	3	1	....	1	....	....	....	....	....	10
Chem.	....	....	....	....	....	....	....	....	....	....	....	....
C.E.	....	....	20	20	....	....	....	....	....	1	....	62
S.E.	....	....	1	1	....	....	....	....	....	....	....	3
E.E.	....	....	12	16	....	....	....	....	....	....	....	40
E.P.	....	3	....	....	....	....	....	1	....	2	....	15
I.E.	....	....	2	1	....	....	....	....	....	....	....	5
M.E.	....	....	....	....	....	....	....	....	....	....	....	....
Met.E.	....	20	2	4	....	....	....	....	....	....	....	68
Min.E.	6	....	....	....	9	2	....	10	6	4	....	88
Grads.	....	....	....	....	....	....	....	....	....	....	....	....
Total Wt.	36	78	152	81	32	24	210	32	24	26	9	704
No.	9	26	76	81	16	8	70	16	12	13	9	336

MINING ENGINEERING

	Min. 1 (3)	Min. 2 (3)	Min. 3 (3)	Min. 7 (2)	Min. 10 (2)	Min. 12 (1)	Min. 101 (1)	Min. 201 (3)	Min. 203 (3)	Min. 205 (3)	Min. 207 (3)	Total—Wt.
Arts	4	5	....	2	8	4	1	....	....	....	....	52
Bus.	....	1	....	4	11	3	....	....	....	....	....	36
Ch.E.	....	....	....	....	1	1	....	....	....	....	....	3
Chem.	....	....	....	....	....	....	....	....	....	....	....	....
C.E.	....	....	....	1	....	1	....	....	....	....	....	3
(S.E.)	....	....	....	....	....	....	....	....	....	....	....	....
E.E.	1	....	....	....	....	....	....	....	....	....	....	3
E.P.	....	....	....	....	....	....	....	....	....	....	....	....
I.E.	3	....	....	1	1	3	....	....	....	....	....	16
M.E.	....	....	....	....	5	1	....	....	....	....	....	11
Met.E.	....	....	3	....	9	1	....	....	....	....	....	28
Min.E.	6	3	3	7	2	1	....	....	....	....	....	55
Grads.	....	....	....	....	....	....	....	....	....	....	....	....
Total Wt.	42	27	18	30	74	15	1	....	....	....	....	207
No.	14	9	6	15	37	15	1	....	....	....	....	97

serve as a reliable guide which can be used with full justice to the students, to eliminate from any curriculum students whose best interests will be served in another field of scholastic endeavor. If, after using due care under method *A*, too many students enter a particular curriculum, it would seem to be just to a student to deny him continuance in that curriculum if and when his answers in comprehensive examination, taken in conjunction with his scholastic grades, indicate that he is one of the least desirable members of that curriculum.

The authors desire to express their thanks to Wray H. Congdon, Director of Admissions, Lehigh University, for suggestions and some of the data furnished for this paper.

VOCATIONAL GUIDANCE AND STUDENT SELECTION *

By O. J. FERGUSON

Dean, College of Engineering, University of Nebraska

An item which I read several years ago comes to my mind as I think of the subject of vocational guidance. The McGraw-Hill notes of February, 1929, remarked that, "Vocational guidance, as an effective development, has come only since the beginning of the century. But as long ago as 1795, Henry McKenzie protested against 'wasting the years of youth at school, . . . improving talents, without having ever discovered them!' "

That puts the matter very succinctly. Our great concern is to find what a person can do best, then to bend every effort to his development.

It is commonly recognized that modern education should provide for each person that type of training which will do him the most good—not that type which will best develop other men. This idea interpreted in its significant social sense constitutes the basis for our program of guidance and selection.

When such training is provided, there will be more schools for artisans, a clearer recognition of the respective zones occupied by the artisan and by the engineer, and a much enhanced status for professional engineering. The engineering schools will know better what their tasks are and what order of men their students should be. There will be less economic loss from trying to train misfits. And there will be a mighty saving of self respect, moral force, and psychological poise and stability on the part of young men no longer compelled to undergo defeat at the hands of an academic curriculum, in order to receive some education beyond the high school level.

Bulletin No. 588, of the Federal Bureau of Labor Statistics, presents a study of the incomes and earnings in the profession of engineering, for the years 1929 to 1934. In discussing the differences of incomes among engineers, based upon a classification in terms of educational background, the bulletin states that: "At least one out of ten at the bottom of each group, whether a college graduate or not, whether a chemical engineer or a civil engineer,

* Presented at the Conference on Orientation at the 46th Annual Meeting, S. P. E. E., A. & M. College of Texas, June 27–30, 1938.

whether a man with many years of service or freshly out of college, is hardly to be distinguished from a skilled wage earner."

"We do not feel ourselves competent to project from these data what the future holds in store for the high school boy who must be advised as to what type of training will be most advantageous. We hope he may be fortunate enough to encounter wise advice. We dare do no more than point out that in 1929 the average income of graduate engineers with ten years' experience ranged from $3,600 to $4,600 in the various professional classes. In 1929 only 6.4 per cent of the incomes in the United States exceeded $4,000. Furthermore, engineering is a profession in which earning capacity advances and is sustained until late in life. But if in these respects the profession appears attractive on the average, its rewards are not particularly attractive to the poorer or less fortunate engineers. Even in 1929 the lowest-paid 10 per cent of the engineers could hope for no more than $2,500 to $3,000, though they might stay in the profession for 40 years. In 1934, exposed as the profession was to the risks of unemployment, the lowest-paid 10 per cent of the engineers with less than 5 years' experience after graduation earned less than $1,000. Even with 10 to 30 years' experience they earned no more than $1,000 to $1,500. Judged from the basis of money income, there can be no question but that the best of a group of skilled wage earners are in a better economic position than those who struggle to maintain a position on the fringes of the engineering profession."

Do we still ask if engineers need sifting in embryo? We who are in education see many boys struggle without success and drop into the discard, because their hopes, or those of their parents, are without good foundation. Employers of our graduates of the lower levels find these employees unable to advance in their organizations to the responsible openings awaiting them. The lower tenth spoken of in the quotation above might better have been in other callings than "in the fringe of the engineering professions." Why are they there? I believe that the answer is that there has been neglect and lack of proper teamwork back in the early school days when the boys could have benefited by friendly and competent advice.

There exist two supplementary preventatives to these misfits, in early guidance and effective selection. The one is directed toward the education of the student in making his own choice of occupation; the other is the operation of a sifting process by the school, at the admission level. Guidance, though it still has much to gain, has made distinct progress in the technique of college entrance; selection is very sketchy and faulty. Knowing as little as we do about each of these agencies, how far can we go with them?

In the annual meeting of this society one year ago, several speakers pointed out that there are many cities which are doing very effective work in guidance in their public school systems. There are many colleges which are studying their entering students for significant attributes, and their testing processes for validity. There are engineering societies which are assembling data and promoting their use. There are many local groups which are giving generous coöperation with high schools, in interpreting engineering to youthful minds.

The time for guidance does not begin with the freshman year in college. By that time the most effective years for such assistance have passed.

As compared with the mine run of students, boys who enter college with their minds made up as to their professions, such as engineering, law, medicine, etc., evidence either a more advanced maturity or development, or a more positive character. It is not surprising, therefore, to find that ninety per cent of our freshman engineers have gone a step further and even have picked out their branches in the field.

It becomes clear, therefore, that the problem of guidance is one which reaches back well into the schools. Public school men recognize this, as we see by their wide use of courses in civics, student trips to industrial plants and business houses, analyses of vocations, visits to educational institutions, talks by community leaders, etc.

So far as engineers are concerned, the most significant movement in this line is the appearance of the Engineers' Council for Professional Development, with its five-point-program. One of its committees, that on "Selection and Guidance of Engineering Students," is charged with the duty: "To develop further means for the educational and vocational orientation of young men with respect to the responsibilities and opportunities of engineers, in order that only those may seek entrance to the profession who have the high quality, aptitude, and capacity which are required of its members." This committee has promoted studies of engineering aptitudes of over 3,000 students who took tests in English and mathematics, as freshmen. It has furthered the use of literature on guidance, particularly the booklet, "Engineering—a Career—a Culture." It has prepared a manual on guidance to assist counsellors. It has organized local engineering committees to counsel boys. It has coöperated with many agencies interested in guidance, to their mutual advantage. Results from these activities are accumulating, although progress is very slow.

Guidance for all students, non-engineering as well as engineering, is becoming a popular objective. It remains for engineers

to see that the counselling given to those who inquire about engineering is well founded and understandable. For one who would do this work well, there are necessary two credentials, a knowledge of proper counselling practices, and a true concept of engineering. We must exercise care here, for not every good engineer knows how to advise boys, and not every good counsellor understands the engineering profession.

We need the help of psychologists in our studies. But even their leaders seem to be none too sure of themselves. Just now they are building new outposts called "primary abilities," which are believed to be independent of each other. These are named as:

Visualizing
Speed of perception
Memory
Numerical ability
Induction
Deduction
Verbal fluency
Verbal relations
Verbal comprehension.

Whether or not a certain compound of these nine primary abilities may have engineering significance, in contradistinction to excellence in any other profession, is not known. More experimentation should be undertaken by competent observers.

A more elementary and easily usable aid to guidance is the "Vocational Interest Blank," which has been developed to show where a boy's greatest interests lie. This is being used much in personal counselling.

Selection of students has been spoken of as supplementary to guidance. It can be exercised either positively or negatively. We have long possessed all the negative control which we may have cared to exercise. We can pretty much set our own entrance hurdles, as we wish. But we do not have a sufficient positive selectivity. We cannot seek for and discover the young men who should go into engineering. Our selections are made with sieves, rather than with magnets.

But even our sieves are unsatisfactory. No engineer would accept a single I-beam for his bridge, knowing as little about it as we know about the students whom we admit quite readily for enrollment in colleges of engineering. Certainly, we are not less concerned about our product than the bridge engineer is about his. But it does almost seem that the bridge engineer is more troubled by excessive wastage of material than we are in our heavy losses during our process of training.

The engineer in self-protection writes specifications in terms of recognizable characteristics, and properties. The qualities of his steel are clearly prescribed. He will have none other.

We educators write our specifications in terms of processes—a certain program of "heat treatments" through which our material must have gone.

This difference of approach is not wholly inexplicable, though it is difficult to fathom completely. There seem to be three major causes for our poor practices. The first one of these is our backwardness or inertia. We use the easiest known methods for admissions. When parents apprenticed or bound-out their sons, the sons had little to say about it. We have progressed to a point now where the young man is given the right to choose his own profession, and we have so lost sight of realities in defending this right for him, that we have taken none of the responsibility of discovering the basis upon which he may make a wise choice. We have not moved up to our place in line. Until recently we have said to the boy, "You must find yourself, and orient yourself to industry. That's your job. Don't let us influence you!"

A second reason why we have not been a better partner to the boy, comes from our inability satisfactorily to find the specific faculties which are required for engineering. In spite of our excellent general descriptions of engineering attributes, we are still searching for the genes which make engineers. We do not know what engineering aptitudes are.

The third point is the counterpart of the second. We do not know how to examine a prospective engineer, nor what our tests really reveal. We are on insecure footing in trying to explore minds by any tests we yet have established.

These three difficulties stare us in the face: we have not sensed it to be our responsibility to exercise a greater degree of selectivity; we discern only faintly the criteria upon which we should base our judgments; we distrust our ability to interpret our tests, or even to erect revealing tests. But there are things we can do about it. We can venture forward on what we know, and build cantilevers to reach into the unknown.

In our program of selection, a fact of which we must not lose sight is that there are three "levels" popularly accredited to engineering. First, there are the mechanics or artisans who represent the old types of so-called engineers, the types which still exist as engineers in the minds of many laymen. These constitute a large and needed group which must continue to be supplied from some source, whether our schools, or not. Second, there are those who are primarily scientific and technical men, in work ranging from operation, production, and construction, to design and research.

Here, we have the technical engineers. Third, come those whose training in engineering, and ability in leadership have opened the way for advancement to positions of administration and management. These are administration engineers.

As we admit students, we must determine for ourselves what our college responsibilities are to each of these levels. Of course, it is a fact that the latter two groups constitute the professional engineers, while the first group is only of near-engineers. But unless or until there are established over the country suitable free trade-schools for training technicians, our engineering schools will attract many students who should not be in them. And judging from the past, we shall continue to admit many of them, give them a sub-engineering course, or such part of a course as they can assimilate, and pass them out to industry to be adapted to its use, as best they may be.

In the face of this condition, attempting to establish a sound program of selection of the type which searches out promising engineering material and excludes other, is rowing upstream. We wish to attract and retain good engineering material, and delete the sub-professional type. Our schools now operate with many of the latter, and industry absorbs them. If they were strictly to be excluded, there would be no other place for them to go for training, and their pressure for admittance would become extreme. This constitutes another practical problem in school adjustment which is embarrassing to administration and undoubtedly delaying to a program of rigorous selection.

There is only one answer to the question, however, as to whether or not we should put more emphasis upon selection of our students than we are doing now. Certainly we should be studying the possible processes more. Practiced in different institutions and different regions, are such procedures as regents' examinations, college entrance board examinations, standardizing by accrediting agencies, local college examinations, exclusion of lower levels in high-school classes.

We should know more about such standards. How valid are they in picking apt students? What significance, if any, do they have to engineering? Are not all of these methods equally suitable for selecting good lawyers, good teachers, good bankers? Perhaps we are overlooking some of the significant things. Perhaps we are cutting across industry and the professions on the wrong planes. It is not unthinkable that certain groups of personal characteristics might fit a man for eminence in, let us say, patent law, criminology, investment banking, and engineering research; or in surgery, and engineering design; or in medical diagnosis, and consulting engineering. There are certainly great

interprofessional overlaps of skills and aptitudes. Whence come the interests which guide men to this or that application of such faculties? How important are interests in contradistinction to aptitudes? Occupational guidance and student selection are so definitely co-partners in the development of youth that they should be practiced together.

Best present methods of procedure in guidance and selection seem to involve combinations of several elements. So far as we are concerned, coöperation between engineers and the local school authorities is a prime element in approach. There is value in self-rating charts of attitudes and interests. Short pamphlets descriptive of engineering work are needed to establish a background. College curricula may be analyzed for this same purpose. Engineering work may be inspected, preferably under competent engineering guides. Contacts established between questioning students and wise engineers may be most effective. General talks on engineering may precede personal interviews, if desired.

Tests which appear to have some predictive value include mathematics, English diction and vocabulary, visualization, and general psychological examinations. Average standing in high school also has direct significance, for few entrants from the lower quartile ever graduate in engineering.

To bring a few more specific items into the picture, may I speak of our own State?

Through the Extension Division of the University of Nebraska contacts are maintained with all high schools of the State. The director of this work is also the university examiner and the combined responsibilities lend themselves quite naturally to a program of assistance to inquiring students with all types of college ambitions. Descriptive literature is used, leaflets relating to all branches of university work, and all standard college courses. Many students are advised not to enter the University, sometimes because of their lack of preparation or indicated ability, and sometimes because their ambitions cannot best be served there. The E. C. P. D. booklet, "Engineering—a Career—a Culture" is used quite freely in answering inquiries of prospective engineers, and is believed to be the best publication of its kind available.

The director also administers our required classification tests in mathematics and in English. The Ohio State University Psychological Test is given in the same way. These several tests may be taken by the students at their own high schools, under supervision of their own teachers, in the last term of school before graduation.

The results of these tests are available to all colleges of the State when students come to them in the fall. Our advisers have

the reports before them when they meet the newcomers, and base their counsel upon them and the high school records.

The Nebraska Engineering Society is laying plans to contribute the services of contact men to the guidance program of the State as counsellors to boys. This probably will function most definitely in the larger cities, at least, in the beginnings.

The College of Engineering at the University of Nebraska announced last summer and again this spring that it would limit its freshman class to a definite number. The procedure calls for ready admission of applicants who are in the upper three quartiles of their high school classes. None in the lowest quartile may register on the first of the two days set apart for registration. On the second day, if it appears that the permissible number of students may not be reached by those in the upper quartiles, a committee of three scrutinizes the credentials of the lower quartile men and selects for admission such as it considers good risks.

Studies which we have made of the results of college work done by fourth quartile men in years past have led us to believe we are on firm ground in discouraging them very definitely from entering the engineering college.

To summarize:

Vocational guidance and student selection go hand in hand, and supplement each other. We know more about the guidance processes (giving advice) than we do about selection processes. We are not sure of our concepts of elemental engineering attributes. Our testing is far from being clearly indicative. Certainly, nothing like unique significance attaches to our tests, or seems ever possible to them.

In this seeming impasse, we find need for continued effort and study in analyses of engineering talents; research in the comparison of test results with professional success; further enlightenment as to the psychological factors involved.

And to secure these, we must have many capable, persistent, devoted observers and interpreters. What greater duty has this Society than to advance to firmer ground our program of guidance and selection?

FUTURE COLLEGE ENROLLMENTS

By R. L. SACKETT, D.Eng.

Dean Emeritus, School of Engineering, The Pennsylvania State College

The Study of Engineering Enrollments in the January issue of ENGINEERING EDUCATION furnishes material for reflection when certain census information is also considered.

While present conditions are thought by many to be abnormal and therefore are a slippery basis on which to prophesy, there are certain facts which have persisted over a long period of time and which definitely bear on the next ten years. For instance, the *rate* of population increase has been decreasing since about 1860, and the population will reach a maximum around 1960 according to the present evidence. Between 1930 and '38 the enrollment in elementary schools decreased 1,300,000 or about 6 per cent. "If present trends in population continue, by 1960 there will be 10,000,000 empty desks in schools and colleges." * The peak of high school enrollment is estimated by the U. S. Office of Education at 6,135,000 and significantly, at this date, 1938–'39. The high school enrollment has dropped 50,000 in six years in New York City. It is therefore of interest to ask "what of the morrow?"

Engineering Enrollment 1938–'39 † shows an apparent drop in the number of freshmen enrolled this year as compared with '37–'38 but the number of institutions reporting is 122 for this year and was 131 a year ago. Therefore there may be no decrease visible yet.

The number of sophomores is nearly equal and present enrollments of junior and senior engineers is greater than a year ago. The figures may be significant forerunners of effects which will be more apparent in a few years.

Undergraduate enrollments by institutions show marked differences in the proportion of seniors to juniors, sophomores, and freshmen. There is substance for thought in such wide variations. Explanations are more or less evident in a few cases where the number of transfers to upper classes is large. In other cases it may be due to temporary conditions.

The change in enrollment in different curricula is subject to so many other influences than the reduction in college population that little can be said except that educational fashions, financial conditions and social trends such as relief and unemployment payments may have an effect.‡

Child labor laws, incomes and conditions of employment may

* See article by Stuart Chase, p. 183 et seq., *Atlantic Monthly*, Feb. 1939.

† ENGINEERING EDUCATION, Jan. 1939, p. 370 et seq.

‡ "Unemployment Insurance and Its New Problems in Employment Counseling," *Occupations*, Feb. 1939, p. 395.

affect the enrollment temporarily and lead to increases for a time. Invention may lead to shifts in the future as in the past from one curriculum to another. Such influences may lead to new curricula of which there seems to be an over supply at present. The best preparation for unforeseen changes in economic conditions seems to be a foundation of more science rather than less. It is easier to make such a statement than to be specific about how it is to be done. Fundamental subjects have been slowly changing during the 46 years of the existence of the S. P. E. E. The emphasis in and the scope of curricula will continue to change to fit the more permanent evidences of evolution.

NEW MEMBERS

BERRYMAN, LLOYD G., Instructor in Mechanical Engineering, A. & M. College of Texas, College Station, Texas. C. W. Crawford, R. M. Wingren.

CHAPMAN, ROBERT G., Instructor in Mechanical Engineering, Duke University, Durham, N. C. R. S. Wilbur, W. J. Seeley.

GALBRAITH, RALPH A., Assistant Professor of Electrical Engineering, University of Texas, Austin, Texas. R. W. Warner, J. W. Ramsay.

HEM, LAWRENCE W., Instructor in Mechanical Engineering, College of the City of New York, New York City. S. J. Tracy, H. T. Updegrove.

MARTIN, F. F., Industrial Relations Dept., Kimberly Clark Corp., Neenah, Wis. B. G. Elliott, F. E. Johnson.

PINSKY, JOSEPH, Associate Professor of Mechanical Engineering, Colorado State College, Ft. Collins, Colo. J. T. Strate, J. H. Scofield.

REEL, FRED R., Assistant Professor of Mathematics, Lewis Institute, Chicago, Ill. F. A. Rogers, V. T. Sherman.

WESTFALL, ALFRED, Professor of English, Colorado State College, Ft. Collins, Colo. S. L. Macdonald, W. O. Birk.

CASSELL, WALLACE L., Associate Professor of Electrical Engineering, University of Colorado, Boulder, Colo. W. C. DuVall, W. O. Birk.

COMSTOCK, E. H., Dean, School of Mines and Metallurgy, University of Minnesota, Minneapolis, Minn., for re-admission.

DAVIS, WATSON M., Assistant Professor of Mathematics, Armour Institute of Technology, Chicago, Ill. W. C. Krathwohl, J. B. Finnegan.

FOLK, JOHN T., Associate Professor of Engineering, Louisiana Polytechnic Institute, Ruston, La., for re-admission.

GOODHEART, CLARENCE F., Instructor in Electrical Engineering, A. & M. College of Texas, College Station, Texas. L. L. Grandi, M. C. Hughes.

HOTCHKISS, WILLARD E., Maurice Falk Professor of Social Relations, Carnegie Institute of Technology, Pittsburgh, Pa., for re-admission.

HUBLER, JOHN W., Instructor in Agricultural Engineering, Purdue University, Lafayette, Ind. Wm. Aitkenhead, M. W. Todd.

KENT, CLARENCE H., Associate Professor of Mechanical Engineering, College of the City of New York, New York City, for re-admission.

LUKE, CHARLES D., Assistant Professor and Acting Head, Dept. of Chemical Engineering, Syracuse University, Syracuse, N. Y. Louis Mitchell, Earl Church.

SCOTTRON, VICTOR E., Instructor in Machine Design, Cooper Union, New York City. G. F. Bateman, C. H. Young.

WAREING, JOHN F., Instructor in Electrical Engineering, New Bedford Vocational School, New Bedford, Mass. C. E. Tucker, R. R. Lawrence.

CIVIL ENGINEERING PAGE

Notes of interest for members of the Civil Engineering Division.—Editor, M. W. FURR, *Kansas State, Manhattan*

F. T. MAVIS, *Chairman*
H. C. BIRD, *Past Chairman*
F. W. STUBBS, JR., *Secretary*
M. W. FURR, *Editor*
H. T. HEALD
PAUL P. RICE
HALE SUTHERLAND

The Civil Engineering Division of the Society, under the auspices of Committee V, is sponsoring a Conference on Hydraulics to be held at the State University of Iowa, Iowa City, Iowa, June 12 to 15, 1939. For information write Dean F. M. Dawson.

THE CHANGING RESPONSIBILITIES OF THE CIVIL ENGINEER *

H. T. HEALD, *President*

Armour Institute of Technology

In considering the responsibilities of the civil engineer as they affect our educational policies, it is well to keep in mind two distinct phases of the problem. First, what are the broad responsibilities of the civil engineer as a citizen and as a professional man, and how are these responsibilities likely to be presented to him; and second, what are the specific new developments in the civil engineering profession which are likely to be reflected in the technical parts of a civil engineering curriculum? Both of these phases of the engineer's activities are changing. The future does not hold any lack of opportunities for him but it does definitely indicate that he may find these opportunities in different types of work.

General Responsibilities.—Let us first consider the broader phases of the civil engineer's responsibility. Recent years have seen an increasing emphasis placed on the problem of educating engineers to a greater appreciation of the social and economic aspects of their work. Certainly the work of the civil engineer has always had and will continue to have an important impact upon society as a whole. This imposes a direct responsibility upon him to acquaint himself not only with the technical details of his work, but also to give careful consideration to its broader phases. At the same time, it imposes a responsibility on engineering educators who determine educational policy to arrange the civil engineer's course of study so that every student may acquire the broader background necessary to a fuller understanding of social and economic problems.

Recognizing that the work of the engineer may be interpreted in a general way as that of using the forces and materials of nature for the benefit of mankind, the engineer admittedly occupies an important place in our social structure. Irrespective of our agreement or lack of agreement with current trends

* Paper presented at Divisional Meeting, A. & M. College of Texas, 46th annual meeting, S. P. E. E., June 27–30, 1938.

in government, we cannot fail to realize that this country is definitely committed to provide a higher standard of living for the population as a whole. The civil engineer whose whole usefulness rests upon his service to mankind can scarcely disagree with such an objective, and substantial progress toward this goal is much more likely to be attained by engineering accomplishment than by abstract theories.

Recent surveys of engineering employment seem to indicate that a larger proportion of civil engineers today are engaged in various types of public works programs. This is likely to be especially true of the younger men entering the civil engineering profession. We know that perhaps seventy-five per cent of the engineers employed by governmental organizations are civil engineers. A recent survey of Armour graduates in civil engineering from 1932 to 1937 shows that 85 per cent are in governmental service. This trend may not continue but it certainly shows the increasing importance of public service as a field for civil engineers. Most of us find little to criticize in the way in which the technical aspects of governmental work are carried on. We do, however, feel that it is entirely too seldom that major decisions as to public policy are placed in the hands of competent engineers. Is not this then a major responsibility of the civil engineer, and one which we should recognize in training young men for the profession? If we can meet this responsibility, we can envision the engineer as having a much greater voice in the councils of men and as participating to an increasing degree not only in the design of public works, but also in major decisions on public policy.

Many of us when we began our study of civil engineering probably thought, at least in the back of our minds, that we should eventually like to become consulting engineers. This seemed to be the ultimate responsibility to which an engineer should aspire. Current trends in engineering practice do not seem to present very great opportunities for the consultant. With the increased socialization of many professional activities, it seems extremely doubtful that any large number of the graduates of recent years will ever be able to find a satisfactory career in independent practice.

The general field of construction has always occupied the attention of many civil engineers and will no doubt continue to do so, but here again much of the work is of a public nature. Certainly then the civil engineer today has an increased responsibility for public works, and this trend may be expected to continue in the future. It is also well to keep in mind that the development of construction as a really organized industry still offers a challenge to the college trained engineer who has a sufficiently broad training and enough vision to realize its possibilities (cf. page 430 of JOURNAL OF ENGINEERING EDUCATION, January, 1939).

It is important to keep in mind these broader aspects of the civil engineer's responsibilities. Our college courses must be planned to make the student fully aware of these things and must, at the same time, provide him with a fundamental scientific training and a sufficient knowledge of professional subjects to permit him to begin the practice of his profession. With the rapidly advancing state of professional knowledge, it becomes increasingly difficult to combine properly all these aspects of the engineer's education in the undergraduate curriculum.

Technical Training and Professional Fields.—In considering the technical character of the civil engineer's responsibility the civil engineering field is indicated by a classification prepared by Frank Kerekes ("Teaching Applied Courses," JOURNAL OF ENGINEERING EDUCATION, May, 1936).

(1) Transportation systems, including highways, railways, waterways, airways, and pipe lines.

(2) Sanitary works, including water supply, water softening, water purification, sewerage systems, and sewage disposal.
(3) Structural projects, including bridges, buildings, tunnels, foundations, dams, locks, and other structures.
(4) Hydraulic projects, including river and harbor work, flood control, water power irrigation, and drainage.
(5) Related fields, such as surveying, construction, city engineering, city management, and valuation.

While all of these divisions will undoubtedly continue to engage the attention of a considerable number of civil engineers, certain developments are taking place which may result in an entirely different distribution of the profession among them. Increasing emphasis on a thorough study of highway transportation, traffic problems and safety, will undoubtedly provide employment for a larger number of engineers in the future. This is borne out by the comprehensive survey of highways now under way on a nation-wide scale. It is interesting to note that highway engineering today is no longer merely a problem in the construction of new roads but has become a case of correlation of the highway with the vehicles which operate upon it, with a full consideration of traffic density, safety, and all the related problems. This is well brought out by a symposium appearing in the June, 1938 issue of the *Proceedings* of the Am. Soc. C. E.

New developments in water supply and sewage treatment, new engineering materials, advances in methods of structural analysis, the new science of foundations, increased emphasis on flood control and power development as well as the growing field of city management, all place new responsibilities on the civil engineer which must be recognized to a greater or lesser extent in planning his college training.

Valuation work is another field of activity which seems likely to occupy the attention of an increasing number of engineers, and the whole question of low-cost housing presents a problem for which engineers and architects have scarcely begun to find a solution.

Finally, in considering the responsibilities of the civil engineer, we should not lose sight of the fact that many civil engineering graduates never engage in strictly professional work. Most of us are aware that there is a steadily growing recognition of the fact that an *engineering education provides a good background for business and for commerce.* I can readily name corporation executives, bankers, real estate operators and men engaged in a host of other activities who were educated as civil engineers.

While it is likely that the number of civil engineering graduates engaged in industrial positions is somewhat smaller than in some of the other fields of engineering, and it may be that these business occupations can scarcely be accepted as specific civil engineering responsibilities, yet it is well to consider them in planning the civil engineer's education.

ENGINEERING ECONOMY PAGE

Engineering economy is that phase of engineering work in which technical plans and operations meet the critical and constructive tests of applied economics.

EDMUND D. AYRES, University of Wisconsin, *Editor*

EQUIPMENT REPLACEMENT FORMULAS

During recent years much material has been published in engineering and trade periodicals, handbooks, and textbooks with reference to the economic factors involved in the replacement of various kinds of capital assets. Most of the authors of this material seem to feel that it is desirable to have a formula, the idea apparently being that problems of this kind can be solved best by using a formula. Formulas do have certain advantages, but they also have certain very serious disadvantages when used in economy studies, and the writer believes that the disadvantages far outweigh the advantages. The greatest objection to most of the equipment replacement formulas is the fact that almost invariably they contain fundamental errors.

The writer recently made a careful study of ten of these formulas and found that every one of them contained at least one serious error. No attempt was made to select formulas which contained errors; the formulas studied are those which the writer believes to be most generally used. Some of these formulas, including their serious errors, have secured even wider publicity through having been republished in other articles and even handbooks and textbooks.

The formulas studied contain so many errors that it is not possible to discuss all of them. The three most common and most serious errors are: (1) charging unamortized value of present equipment against proposed equipment, (2) crediting proposed equipment with a saving in overhead in direct proportion to the saving in direct labor, (3) crediting proposed equipment with the full value of any saving in floor space or any increase in capacity, regardless of whether these potential advantages can be used or not.

Nine of the ten formulas studied contained the first error. Only three of the ten contained the second error and only one of the ten contained the third error, but in several other cases it was not possible to determine definitely the attitude of the author of the formula with respect to these points. As stated previously there were a number of other serious errors which cannot be discussed here because of space limitations.

Equipment replacement formulas generally attempt to answer one of the following questions: (1) what will be the percentage return on addi-

tional investment in new equipment, (2) how soon will the new equipment pay for itself, (3) how much can one afford to pay for the new equipment? It is the writer's opinion that formulas are not satisfactory for use in equipment replacement studies. It does not seem possible to write a *simple* formula which will answer correctly any of the three questions referred to in this paragraph.

After having devoted a great deal of time to an attempt to derive a replacement formula which was both correct in principle and simple enough for satisfactory use, the writer has come to the conclusion that the best way to make an equipment replacement study is to charge both present and proposed equipment with the annual charges necessary in producing expected annual output with each equipment. The writer would prefer this method even if a satisfactory formula could be derived, as he believes that a comparison of total annual charges for each equipment gives a much better comparison than could possibly be obtained from any formula.

Fortunately it is never necessary to obtain the answer to any of the three questions which a replacement formula is ordinarily intended to answer. One never needs to know what will be the percentage return on additional investment. The actual investment, in both present and proposed equipment should be charged with the rate of return which is necessary to make such an investment attractive and the machines compared on the basis of the difference between the total charges shown by the study, including both investment charges and operating charges. It is never necessary to know how soon the new equipment will pay for itself. The investment in each equipment studied should be charged with a depreciation rate corresponding to the time during which the equipment is expected to pay for itself. It is never necessary to know how much one can afford to pay for new equipment. It is always possible to obtain the price of new equipment from the company which is seeking to sell the new equipment.

One of the reasons why outright errors in replacement formulas and unsatisfactory methods suggested for making replacement studies have not had worse results is that up to the present time these formulas and methods have not been used very generally in industry. The writer believes that definite replacement studies will be used more generally in industry in the future and he feels that errors of the sort mentioned above are apt to cast discredit on the entire subject which we call engineering economy.

PAUL T. NORTON, JR.,
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ENGLISH NOTES

DEVOTED TO THE INTERESTS OF TEACHERS
OF ENGLISH IN ENGINEERING SCHOOLS

J. L. VAUGHAN, *Editor*

ENGLISH COMPOSITION IN COLLEGES OF ENGINEERING

By GEORGE SUMMEY, Jr.

Head of the Department of English in the Agricultural and Mechanical College of Texas

This is Chapter II of the report on instruction in English in engineering colleges.

In the preparation of this chapter the writer has examined a mass of material received by the Committee on English from departments of English, presidents and deans, instructors, engineering graduates, and employers, in answer to the committee's questions concerning content and methods of instruction, successful or unsuccessful experiments, attempts to stimulate interest in English on the part of engineering students, results desired, and results achieved.

As the committee has not conducted a factual survey, the material cannot be reduced to statistical statement, because the questions gave much room for varieties of opinion, emphasis, or factual statement. For these reasons the writer of this chapter cannot hope to count authorities for and against every proposition that must be mentioned, or couple a warranted solution with every problem the survey has raised. Perhaps the best one can hope to do is to set forth some of the problems we have to face.

The Ruling Purpose in Freshman English Composition

The well known report by Professor Oscar J. Campbell entitled *The Teaching of English Composition* (1934) outlined as follows two rival theories of the function of freshman English composition:

(*a*) *Mechanical skill*—"competence in 'spelling, punctuation, paragraphing, logical and clear transition, and accuracy

and variety in sentence structure'—*the very qualities . . . which should be expected of entering freshmen.*" (Italics not in the original.)

(*b*) *Training in thinking.* Those who hold this theory emphasize the necessity of emphasizing material rather than words, of challenging the freshman's mind, of inducing the student to use living material and to make his thoughts articulate. "A student's freshman year is one of the times in his life when his new intellectual acquisitions are the richest. They will remain confused and of little significance unless he is given just that opportunity to articulate and express them offered by a course in systematic writing."

According to the first theory, matters of form are vital; thought and expression may wait until the semiliterate freshman has had enough drill, brutal drill if necessary, to be made over into a literate college student. Those who take this view must logically admit that a freshman who turns out to be well prepared should be excused from the course and allowed to give his time to something better. In actual fact it appears that few institutions exempt superior freshmen from the usual freshman course. Messrs. R. T. Fitzhugh and C. B. Hale of the University of Maryland reported in 1938 ("The Maryland Plan," in *School and Society*, September 3) that of forty-seven institutions they studied by means of questionnaires, only four exempted students from freshman English.

The Campbell report makes the significant remark that most of the criticism of freshman English is aimed at the sort of course that emphasizes drill in the so-called mechanics of writing. "If freshman English be regarded as devoted primarily to the elimination of errors in style, the movement to excuse all students who write respectably and even to abolish the course, requiring those needing training in mastery of the conventions to gain it without obtaining college credit for their practice, is a logical one."

Those who believe that freshman composition should stimulate thinking and adequate expression through systematic work in writing will, if they are to be consistent, either exclude unprepared freshmen or put them in remedial courses. If admission to college is so easy that a large percentage of the entering freshmen need drill in what is admitted to be high school material—spelling, grammar, punctuation, the elements of sentence structure, and simple composition—the choices are as follows:

(*a*) To apply the drill-for-mechanical-skill theory in all sections—presumably upon the theory that we must save the weak and let the strong look out for themselves.

(*b*) To section the students and apply the thought-and-expression theory to the high group, the drill-for-mechanical-skill theory to the low group, and either theory or a blend of the two to the larger middle group.

(*c*) To make such a compromise between the two theories as the stubborn facts require.

Compromise practice is very common, especially in state-supported institutions that have too little choice among applicants certified by accredited high schools. It is obvious that a teacher who finds unprepared students in his sections and cannot get them removed to trailer sections or remedial courses must do as well as he can with them in the regular course.

As might have been expected, answers to the English Committee questions favor in general a compromise opinion—that although drill in grammar and other matters of form is necessary, freshman English composition should be much more than drill in the so-called mechanics of writing. It is a commonplace that we must not only help the student establish the habit of using correct English but also see that he thinks well, makes orderly composition plans, and writes simple, clear, straightforward, and reasonably effective English. The frequency of remarks in favor of composition material related to the student's major field of interest indicates that the writers consider English composition much more than drill in a vacuum.

Happy the colleges that can exclude the semiliterates. The more numerous English departments that must care for scores or hundreds of unprepared students duly certified for admission to college must steer a difficult course between two evils—spending precious time reviewing high school material, or teaching over the heads of perhaps a third of their students. Unfortunately there is good evidence that poor preparation for college English is a nation-wide problem. To quote Messrs. Fitzhugh and Hale once more: "It would seem inescapable from this liberal canvass of state universities that large numbers of students everywhere enter with seriously deficient training in grammar, usage, and composition, and that the universities in self-defense are being forced to do the work of the secondary schools. Why should this be so? It is easy to lay blame on the harassed high-school English teacher, but does it not really rest upon those who plan curricula and assume that children speak and write correct English by instinct? And is it too much to say that faulty training in English composition is the one glaring nation-wide failure of our public school system?"

Strong words, but no stronger than those in a private letter to the writer of this chapter from a dean of engineering who is not

being elsewhere quoted: "So far as I have been able to analyze the difficulty, it goes back to the activities of the so-called educationists, whose half-baked theories of child psychology have operated in the direction of removing nearly all traces of discipline from preparatory school work. I know that up in our part of the country the so-called grammar schools no longer teach grammar and the high schools give the students no practice in composition. The result is that our own freshman classes are engaged in such subjects as diagramming of sentences and parsing of words—subjects which in my elementary school days were taught to me before I was twelve years of age. Any reform that is to be made will have to take the direction of replacing the people who now dictate the teaching policy; and I know that this will not be an easy undertaking."

Our English Committee material makes it clear that a common and apparently necessary compromise between the rival theories outlined in the Campbell report is a differentiation between first-semester work (largely grammar and mechanics) and more advanced work in the second semester, with increased emphasis on thought and composition.

Let there be no mistake about the very common practice of including grammar drill in the freshman course. If the students need such drill, no theory ought to stand in the way of our giving it or seeing that it is given; but the necessity of drill in the rudiments of grammar and usage arises from an evil state of affairs that ought to be remedied.

The following remark from Professor Homer N. Nugent of the Rensselaer Polytechnic Institute throws doubt on the assumption that English departments must give the kind of drill to which the Campbell report objects: "One of our most interesting experiments has been to devote very little time to the teaching of elementary mechanics such as spelling, punctuation, and sentence structure. Students are required to make up their deficiencies so that class instruction may be devoted to the selection, organization, and presentation of material. Since this policy was adopted some ten years ago, the percentage of students passing the course has increased rather than decreased, although the same high standards of correctness have been maintained."

Subject Matter of English Composition

The Campbell report, which strongly recommends that freshman composition be systematic work in thinking and expression, outlines three alternative and competing suggestions concerning subject matter, toward which suggestions an eclectic attitude may be wise.

1. That for the average English instructor the best topics for composition are those that are drawn from the teacher's special field, English literature.
2. That composition must concern itself with the whole thought-world of the student, which in all probability is not that of English literature.
3. That the freshman's work in English composition should be correlated with other courses in his curriculum, such as freshman courses in history, economics, and literature. "According to this scheme, the various sections of freshman composition would be taught by instructors trained in both English and some one of these suggested fields. The student could thus choose as his section the one most closely related to his interests and his general educational program."

The suggestion that English literature be used as the chief source of material for papers is farther from the minds of those who have answered the English Committee questions than the second, which recognizes that many of our students are unfamiliar with English literature. Many whose opinions are worth heeding believe that engineering freshmen should write on subjects related to their major subjects—to which opinion Professor Karl O. Thompson and other members of the English staff at Case School of Applied Science raise the formidable objection that freshman students are not well enough acquainted with engineering to use technical subject matter. Others believe that our freshmen will be better educated if they are encouraged to write about matters that equally concern future lawyers or business men. No doubt all would agree that our problem is to get our students to write purposeful and not perfunctory papers; but unfortunately there is no magic formula for this important enterprise.

Though there is a strong current of humanistic opinion in every group that answered the English Committee queries, there are some that would reduce English composition to scientific or popular exposition, engineering reports, and business letters; and some would reduce literature, so far as composition courses are concerned, to material closely related to science, business, and engineering. Those who take the radically "practical" view may well heed the following entry in the Report of Conferences at the S. P. E. E. session of 1938 (JOURNAL OF ENGINEERING EDUCATION, November, 1938, p. 196): "The papers read by Dean H. P. Hammond, President Karl T. Compton, Dean O. J. Ferguson, and Professor F. B. Seely, as well as one by a representative of teachers of English, Professor J. Raymond Derby, showed that schools of engineering look to the departments of English not merely for

training students in correct and effective expression in speech and writing but also for introducing them to the aesthetic and social values of literature and the related arts." If it be objected that this remark applies only to literature and not also to English composition, the answer is that books of readings and library assignments are commonly used as adjuncts to handbooks or rhetorics in composition courses, and also that good reading and good writing are closely interrelated.

Two variations of the third composition plan listed in the Campbell report, either one serving the purpose of correlating freshman composition with other freshman courses, are as follows: (*a*) Professor Alvin Eurich's suggestion that teachers of English coöperate with each departmental division instead of conducting separate classes in English composition, but continue to be members of the English staff, and (*b*) Professor Campbell's own suggestion that "each student be assigned to a tutor in composition to whom he would bring all his written work throughout his college course for comment and advice."

Objections to the two forms of the third plan will suggest themselves—the difficulty of finding teachers who are well trained not only in English but also in another field, and the cost and administrative difficulty of brigading English teachers with other departments or of supporting a tutorial system. To what extent such plans have been tried in freshman work is not made clear by the answers to the committee queries. In such advanced courses as technical writing, as Professor A. M. Fountain has shown ("A Study of Courses in Technical Writing," 1938), some institutions actually have systems of interdepartmental coöperation. For example, says Professor Fountain, "one of the most common plans of joint effort between English and technical courses is that of a conference between instructors in the two departments, and the choosing of topics for papers to be written through the term. Colorado State, Delaware, Idaho, Maine, M. I. T., Montana State, Oregon State, and Rose Polytechnic Institute use such methods. In addition, at Delaware, the purely technical papers are frequently submitted to the English department for checking and review. . . . At M. I. T. the technical instructors not only aid in a choice of subject matter, but also frequently attend English class and join in criticism of the material offered."

Requirements and Electives

According to Professor A. M. Fountain's study above cited, the average English composition requirements in 117 schools of engineering that hold institutional memberships in the S. P. E. E. are

as follows, the units being quarter-hours: elementary composition, 7.40; advanced composition, .59; technical writing, 1.40; business English, .11; journalism, .03—making a total of 9.53. (Additional English courses—literature with 2.75 quarter-hours and public speaking with 1.20—make the average English total 13.48 quarter hours.) The fact that elementary composition occupies 7.40 of the 9.53 composition units is evidence that freshman composition is well entrenched; second in importance among composition courses is technical writing.

The most important fact concerning English electives is that engineering curricula are too crowded to leave much room for them. Beyond this statement of familiar fact, no quantitative statement is warranted by the available material.

Amount and Kinds of Writing Required

Many of the answers to the English Committee questions are in such general terms that no quantitative general statement of a standard amount of writing is possible, and obviously the amount of paper work that can be carefully read by the teacher and discussed with him in a private conference will vary with teaching loads. Specimen answers are as follows: 5,000 words a year; one long paper each quarter and one to three short papers each week; weekly themes and reports on reading; thirteen short papers and one 1,500-word paper in the first semester, six 500-word papers in the second semester; "much written work," whatever that may mean; home and class themes (number not specified), greater weight being given to class themes. The last entry is a recognition of the ubiquitous ghost writer about whom many of us have heard too much.

It appears to be generally agreed that exposition, popular or scientific, is the most important type of writing in the unspecialized composition course, with argument second. There are only scattered remarks in favor of the other types, with the exception only of letters.

Private Conferences

Answers to the committee queries yield so little quantitative information that one can only say that conferences with students in English composition are commonly considered necessary and that systems of conferences are nearly universal. "The conference system," says Professor S. M. Tucker of the Polytechnic Institute of Brooklyn, "is essential. Instruction in the classroom is generalized; the conference develops the individual student."

It must be added that in certain institutions conference work

is hampered by lack of convenient and reasonably private staff rooms and by heavy teaching loads or by heavy student curricula. An experienced teacher in a college that has no obligatory system of conferences remarks that weak students who are on the edge of failing are more ready to come than the able students who are better worth the teacher's time.

Handling Special Groups of Students

Answers to the English Committee queries warrant only the broadest statements—that sectioning on the basis of ability and preparation is employed here and there, perhaps more widely than the answers show, and that a few institutions exempt well prepared students from part or all of the usual freshman requirement or from an advanced course that is usually prescribed. For example, Professor H. L. Creek reports from Purdue University that "freshmen with the best preparation and ability—nearly one-third of the total number—are assigned to a more advanced course in composition in which there is relatively little attention to the mechanics of writing except in connection with themes, the emphasis being upon longer papers, upon originality of thought and style, and upon contemporary literature as a source of ideas. Students who do well in this course are excused from further required composition."

Though there is no uniform practice concerning unprepared freshmen, we are informed by Messrs. Fitzhugh and Hale (article cited above) that of forty-seven universities reporting, thirty-seven offer remedial work of some sort for students with deficiencies in English. "Of the thirty-eight universities which give prognostic tests, twenty-eight place deficient students in special sections, seventeen permitting no credit and eleven allowing credit under certain circumstances." Elsewhere in the same article Messrs. Fitzhugh and Hale list as follows the purposes underlying the various schemes for handling deficient students: "(1) To select the dull and unprepared; (2) to give them necessary training under more efficient conditions than prevail for them in the regular courses; (3) to give credit to those who improve; (4) to keep the worst from contaminating the others and seriously reducing the efficiency of instruction (it is the opinion of our freshman English staff that achievement of this end alone would justify the special sections); (5) to allow for correction of test results; (6) to give the eminently superior (2 per cent to 5 per cent) a freer hand in flying sections."

Where admissions are controlled, the problem of the unprepared student need not be serious. Where admission is by high-

school certificate with no validating examination, the problem may be so acute that only heroic measures can meet the situation.

Promising Experiments

A few of the more interesting experiments in the teaching of English composition are worth citing. The first of these is the Florida plan of laboratory work, outlined in the *English Journal* for May, 1937. "The comprehensive Freshman English course of the General College of the University of Florida," says the course chairman (Professor J. Hooper Wise), "requires five class hours per week, distributed as follows: one in lecture sections, two in discussion groups, and two in the Writing Laboratory. The course has for its basic aims the engendering of the ability to get the meaning from the printed page with a more than average rate of speed, to enjoy good writing, and to communicate ideas effectively in both oral and written discourse." Features not already mentioned are capitalizing on student interests, systematic work on vocabulary, lectures on timely topics (in large groups) and subsequent discussion of the lectures in groups of about thirty students; systematic tests of the student's progress; use of motion pictures as an introduction to drama; study of various literary forms—short story, biography, novel, poetry—after a careful and persuasive approach; much parallel reading; a writing laboratory with ten tables (six students at each), good lighting, and necessary reference books; practice in oral communication, with the aid of a speech clinic for students who need its services; and finally a comprehensive examination, about 75 per cent objective, intended to measure the student's ability to read, write, and speak.

The University of Washington reports an experiment in cooperation. "Housing the English offices within the engineering group has indicated to students that the subject has some standing; the correction of technical papers, effectively carried on during the first two years of the course, has greatly improved their written work and has thus increased the proportion passing the sophomore test for admission to the required course in English usually taken near the beginning of the junior year. Attendance of the English instructors at the meetings of the engineering faculty has developed a sense of responsibility to the college, and some appreciation of the engineering point of view. . . . The instructor's library, supplemented through University funds, has made possible a wide variety of contacts."

Professor Burges Johnson of Union College writes as follows: "In freshman English . . . we permit *no* sections *larger* than twenty-four, and hope to reduce this to twenty. These are conducted in seminar fashion, the students sitting around tables, and a

great deal of discussion of student papers by fellow students is encouraged. One peculiar feature of our work is the requirement every little while that students shall set down on paper a condensed statement of their ideas on a given subject in the classroom *in ten minutes*, with no forewarning. These papers are then collected and with the aid of a lantern are projected on the wall in a semi-darkened room, and the members of the class call out criticisms of spelling, grammatical usage, clarity, and good taste. The students seem to dread this ordeal far more than the criticism of a teacher, and write as well and as clearly as they can in these tests. We are able to take each student's work through the year and study his progress when writing under such difficult conditions."

Under the heading "Attempts to Stimulate Interest in English," Professor H. A. Nugent of the Rensselaer Polytechnic Institute says, "For some years, we have not felt the need of stressing the value of English, because our colleagues in other departments do it for us. . . . The fact that students are working on a graduating thesis at the time they are taking the course in applied composition makes them eager for the assistance they can derive from it. Moreover, the practical value of English is demonstrated to the students by the fact that members of the department supervise such activities as the debating club, the student publication, the dramatic club, and student announcing and broadcasting over our radio station."

How Effective Is Our Work in English Composition?

A categorical general answer would be the height of rashness. Witness the following citations. From an instructor in Brown University: "It is hardly necessary to admit that the work in composition is not 'as effective as might be desired.' It never is." From a dean of engineering: "The freshman work in composition has been fairly effective." From another dean: "Any institution satisfied that its work is 'as effective as might be desired' is certainly in a rut." The chairman of an English department answers, "No. We are always seeking to improve, and we vary our practices from time to time. Many difficulties need to be overcome; perhaps some of them cannot be. Aptitudes, special interests, prejudices, early environment, college tradition, weaknesses in pre-college training, an unwillingness to do the necessary laborious work in acquiring any real ability to write or speak—all these present obstacles to be faced."

The last citation is a reminder that the effectiveness of our work in composition depends partly on forces that are not entirely within our control. Some of these are teaching loads, the traditions and cultural atmosphere of the college, the size and efficiency of the

library system, the presence or absence of such facilities as personnel departments and speech clinics, the quality of our students and the strength of their desire to do their English work well, the demands made upon students by subjects other than English and by extracurricular affairs, and the amount of help given by the staffs of other departments in encouraging the habitual use of sound and competent English. There is room here for discussion only of the last three.

How Good Are Our Engineering Students?

Evidence from every quarter, including the great Pennsylvania study ("The Student and His Knowledge," Carnegie Foundation, 1938), makes it clear that the colleges are getting many of the weaker graduates of high schools and missing many of the ablest. And we all know that many students bring to college stubborn bad habits of grammar, spelling, and pronunciation, and that many are slow or otherwise incompetent readers. To awaken all of these to an effective desire to remedy these deficiencies and to teach them the admittedly difficult art of writing is beyond human power. Habits cannot be remade by six semester hours of freshman English; some students are satisfied with their poor English; some are too busy with sports, amusements, or "activities" to take their English work seriously; some reject English that butters no bread (so they assume) in favor of civil engineering that promises a living.

Every college officer who has studied the results of prognostic tests in English knows that our students vary widely in knowledge of words, ability to read, knowledge of usage, and ability to think. To take an example from the Agricultural and Mechanical College of Texas, a test of spelling, punctuation, usage, and sentence structure given to freshmen in October, 1937, showed the following results: 1st decile, 26–66 of a possible 250 points; 2 decile, 67–78; . . . 9th, 147–166; 10th, 167–231. Of the students in the lowest fifth, only 23 per cent passed the first-semester freshman course, as against 97 per cent in the high fifth. Scores made a week later in a 150-word vocabulary test yielded nearly the same results.

It is impossible to reconcile the opinions reported to the Committee on English concerning engineering students in our English classes. For example: teaching engineering students is a thankless task; they are neither better nor worse than liberal arts students; they have more orderly minds than other students; "the engineering group . . . is in its general responsiveness and capacity the lowest group but one—optometry—with which our department has contact"; they are unresponsive because their minds are set against English. Since the answers disagree, one must turn once more to

"The Student and His Knowledge": "The engineers, for whom a general test in liberal arts and sciences would appear as little appropriate as for any group, from a curricular point of view, score a trifle better than the A.B. group for which the test might be thought to have been designed" (p. 89). "The engineers . . . secured their creditable scores in the non-scientific subjects of the test in spite of an average of 79 hours spent in their technical curriculum and crowded chiefly into the two years immediately preceding the examination. To explain this, it is believed that the group is for the most part the result of unusual selection carefully maintained. Such minds naturally tend to learn more than merely what the curriculum requires; they are inclined to organize and to retain better than others what they learn. . . . More than any other single vocational division of the undergraduate population the group consists of fine minds that have an attractive 'place to go' " (p. 112).

Significant as this testimony is, it only shows that engineering students are relatively good. The sad fact is that many engineering freshmen are no better than weak students in other curricula.

That engineering students have little time for English is almost a commonplace. For example, the University of Washington reports that "the work in composition, literature, and speech has not been so effective as might be desired, largely because of the small amount of time and attention devoted to these subjects." At the University of Utah, the regular course of study is reported to be "so heavily loaded that it allows little time for electives." The extent to which sports and activities further reduce the time given to English is not within the matter of this chapter.

Are the Other Staffs Doing Their Share of the Work?

Nothing need be added to what Dean Hammond has said in the first chapter of this report concerning the recognized duty of the whole college staff to require good English in every paper and in class speech. Yet the fact is that in some institutions some of our colleagues neglect this duty and that some set a harmful example. Most of the answers to the English Committee queries either say nothing about coöperation in the enterprise of good English or else dismiss the subject with euphemisms such as "cordial relations" or "fairly good coöperation"; one writer speaks of strained relations between the English staff and the staffs of other departments; some deplore the evil example set by certain teachers of science or technology. If our colleagues hinder or fail to help, many of our students will resist our efforts and forget most of what they learn in our courses. Fortunate are the institutions—happily there are some—in which there is a tradition of coöperative effort

and the necessary machinery for enforcement of a reasonable standard of good English.

It need hardly be said that we who teach English composition in colleges of engineering are far from satisfied with the results of our work. We cannot escape the conclusion that despite all we can do, many of our students resist the processes of education and fail to use what little they learn. It is disturbing to learn that more than one institution finds elementary drill necessary even in the somphomore year. The plain fact is that no English staff, however gifted and diligent, can make good writers of all the freshmen who now manage to enter college. Perhaps the true measure of our success is the percentage of honor grades we can honestly report.

A Few Conclusions

Despite all that the answers to the English Committee questions have left uncertain, a few conclusions are safe:

1. That our freshman English composition courses are necessary, and that further courses in writing, not necessarily in the English department, are held by many to be desirable.
2. That many of our entering freshmen are so deplorably ignorant of English that we must spend much of our time in elementary drill for which no college credit ought to be given.
3. That the freshman composition course ought to be much more than drill in grammar and mechanics. It ought to call for competent thinking and systematic work in composition.
4. That the effectiveness of our work depends on much more than teachers and course plans, other major influences being teaching loads, curriculum loads, selection of students, and the attitude of the whole staff toward student English. This fact may well be brought as forcibly as possible to the attention of deans of engineering and heads of engineering departments.
5. That teachers of English composition have been and continue to be ready to coöperate with the staffs of other departments, and that we reasonably expect them to help us in the joint enterprise of helping students form good habits of thought and language.
6. That we need not yield to the demands of those who would drive the humanities from the campus. Those who stand high in the counsels of the S. P. E. E. agree that departments of English are expected to introduce their students to the "æsthetic and social values of literature and the related arts." How much of this can be done in the time and with the facilities at our disposal belongs largely to the later chapters of this report.

THE T-SQUARE PAGE

DEVOTED TO THE INTERESTS OF THE
DIVISION OF ENGINEERING DRAWING

F. M. PORTER, *Editor*, University of Illinois

PHILOSOPHIZING DESCRIPT

At the annual meeting of the Drawing Division at Texas A. and M. College last June, opportunity was afforded the writer to comment briefly on a coördinated course of Engineering Drawing and Descriptive Geometry. In all probability there will not be exactly the same theory or ideology governing the content of this coördinated course as there is governing that of the two separate courses of Engineering Drawing and Descriptive Geometry. There comes, then, the problem of establishing a plan which resolves ideals and goals into practical procedures.

The basic aim of any course in drawing undoubtedly is to teach students to interpret and convey ideas by intelligent use of the graphic language of drawing. To do this, the majority of us turn to one of two or three "best sellers" in this field. When it comes to teaching descriptive geometry, however, our aims seem less clear, with the result that a wide variety of textbooks is used, all with apparent equal satisfaction, yet no two alike or in some cases even remotely similar. How, then, and where, into many drawing courses using one book, can the work of descriptive geometry be introduced, using any one of a number of apparently good texts? How can we philosophize descript? In the first place we should answer to ourselves the age old question "of what use is descriptive geometry anyway?" and we should do this in the light of present day needs of engineering education, free from prejudice and emotional bias.

It seems reasonable to assume that descriptive geometry has at least four kinds of uses and values. First, there are those uses which may be classified according to time; *i.e.*, those which can be used at the present and those in the future. These latter then involve "cold storage" learning. Second, there are those uses which may be characterized as providing background of understanding for something else as contrasted with those of instrumental value in solving particular problems. Third, there are the values of mental discipline and training in logical and sequential thinking that accrue from the study of the more involved portions. Lastly, there is the somewhat questionable use that descript develops a higher ideal of accuracy, neatness and orderly method of thinking. There seems also to be a fifth value, which is administrative rather than educative in that it serves as an implement to eliminate the misfits.

In philosophizing descript, one must reconcile the somewhat conflicting ideals implicit in the first two values mentioned above. If we consider the background values more important than the instrumental, then the content of our course will be considerably different than if we teach descriptive geometry primarily as a means of solving present and future problems of design. No teacher will consider only one or the other, but will strive to effect a balance between the two. In a coördinated course, this balance is a more potent factor than when drawing and descriptive geometry are taught separately.

Descriptive geometry is the science upon which rest the principles of engineering drawing, and drawing is concerned with representing three-dimensional space relations on two dimensional paper. What greater need is there than that freshmen engineers acquire early in their course the ability to visualize these in-space relations of points, lines, planes, etc., and graphically to represent them on two dimensional paper? This can most effectively be done through the study of descriptive geometry. Seeing problems "in space" and understanding their solution is far more important than recognizing and remembering certain drafting board procedures involved. There is no question but that students should learn some of the fundamental problems involving point, line and plane description, intersections and developments. Could not part of the time

now used (and perhaps not too efficiently) in the descriptive geometry course, be better employed in the work of engineering drawing if only the time were there available? Are we not inclined to put more work than is really needed in the term of descript because the term must be filled? If this is answered affirmatively, then one effective remedy is a coördinated course in which descriptive geometry assumes new life and has new meaning.

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Assistant Professor of Mechanical Engineering,
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* * * *

The winning drawings in the 1938 Drawing Competition are being held by the Secretary of the Division at College Station, Texas, and will be sent to any institution desiring to exhibit them. The drawings weigh 31 ounces. Transportation costs must be borne by each institution desiring to exhibit them. Address: H. C. Spencer, Secretary, College Station, Texas.

SUMMER SCHOOL FOR CHEMICAL ENGINEERING TEACHERS

The Second Summer School for Chemical Engineering Teachers will be held at The Pennsylvania State College June 23 to 30, 1939, the week following the annual meeting of the S. P. E. E. It is planned to have three periods of one hour each in the mornings and one period of one and one-half hours duration in the afternoons. This will complete the scheduled topics by 3:00 P.M., the remainder of each day to be devoted to recreation.

The regular Chemical Engineering Division conferences will be integrated with the school. The first of these will feature a paper on "The Teaching of Thermodynamics" by B. F. Dodge (Yale) and a second paper on "Kinetics" by K. M. Watson (Universal Oil Products Co.). The second conference will be devoted to a symposium on "The Teaching of Unit Processes," and is in charge of R. N. Shreve (Purdue).

The general theme of the school is to be "What Should We Teach and How Can We Teach It?"

Each topic in the schedule of the Summer School will be under the complete supervision of a leader. The list of topics and leaders are:

Teacher Qualifications	A. B. NEWMAN (C. C. N. Y.)
Service Courses	W. N. JONES (Carnegie)
Instrumentation	R. Z. RAGATZ (Wisconsin)
Introductory Calculations	E. L. MCMILLEN (Lafayette)
Fluid Flow	J. H. RUSHTON (Virginia)
Heat Flow	T. B. DREW (Du Pont)
Evaporation	W. L. BADGER (Dow Chemical Co.)
Laboratory Equipment	H. MCCORMACK (Armour)
Distillation	G. G. BROWN (Michigan)
Drying	R. C. ERNST (Louisville)
Absorption	A. P. COLBURN (Delaware)
Extraction	J. C. ELGIN (Princeton)
Crystallization	W. R. MCCABE (Carnegie)
Filtration	H. A. WEBBER (Iowa State)
Classification, etc.	L. T. WORK (Columbia)
Economics	W. M. COBLEIGH (Montana)
Graphical Calculations	J. H. KOFFOLT (Ohio State)
Chemical Technology	J. R. WITHROW (Ohio State)
Graduate Programs	F. C. WHITMORE (Penn State)
Plant Design	F. C. VILBRANDT (V. P. I.)
Senior Projects	D. S. CRYDER (Penn State)
Comprehensive Problems	O. A. HOUGEN (Wisconsin)

From present indications the attendance is estimated at 125 men, nearly half of whom plan to bring their wives and families. This should be one of the greatest gatherings of chemical engineering teachers in history.

R. C. KINTNER, *Chairman,*
Ch. E. Division, S. P. E. E.

NECROLOGY

Rear Admiral Ralph Earle, U. S. N. (retired), president of the Worcester Polytechnic Institute, died suddenly at his home, 11 Boynton Street, Worcester, Mass., on February thirteenth. He had been confined to the house for several days by a slight attack of grippe, but was apparently much better when, on the morning of his death, he went to the Institute to lead, as was his wont, the first chapel exercise of the new semester. Midway in his address he fell to the floor, stricken with a cerebral hemorrhage. He was carried to his home, where, two hours later, he died.

Admiral Earle was born in Worcester, May 3, 1874. He attended the public schools of his native city and for a time was a student at the Worcester Polytechnic Institute. Receiving an appointment to the United States Naval Academy, he took high honors in his course, and was graduated in 1896. His naval career, falling within the period of two wars, was exceptionally brilliant, and culminated in his appointment as chief of the Naval Bureau of Ordnance, which office he held throughout the term of America's participation in the World War. Under his direction, the Bureau originated and had a major part to play in two of the greatest accomplishments of the war—the construction of the North Sea Barrage and the design and construction of the 14-inch 50 calibre railway batteries that saw active service in France. The first of these achievements was the culminating step in the combating of the submarine; the second resulted in the cutting of the enemy's main line of communication, after which, in the words of General Pershing, "nothing but surrender or an armistice could save his army from complete disaster."

Retiring from the Navy in 1925, Admiral Earle became the sixth president of the Worcester Polytechnic Institute. His administration of fourteen years saw much expansion of the building program of the college. His last achievement, announced to the Trustees and the Alumni Council on February fourth, was the successful launching of a million dollar fund campaign to provide a student activities building and a new mechanical engineering building. He was also responsible for considerable expansion of the curriculum, strengthening of the facilities for instruction, and enlargement of the faculty.

Admiral Earle was the author of several books, including "Life at the United States Naval Academy," "Makers of Naval Tra-

dition," and "Practical Interior Ballistics." He was a member of the United States Naval Institute and of many clubs and learned societies, among them the Army and Navy Club of Washington, D. C., the New York Yacht Club, the Worcester Club, the Society for the Promotion of Engineering Education, the American Society of Mechanical Engineers, the Society of Naval Architects and Engineers, the American Antiquarian Society, the Military Order of the World War, and the Military Order of Foreign Wars. He held, among other honors and medals, the Navy Distinguished Service Medal, the Army Distinguished Service Medal, and the Sampson Battle Medal, and was a Companion of the Order of the Bath, and Commandeur de Legion d'Honneur. The honorary degree of Doctor of Science had been conferred upon him by the Worcester Polytechnic Institute, of Doctor of Engineering by Rensselaer Polytechnic Institute, and of Doctor of Laws by Amherst College and Clark University.

Distinguished naval officer, eminent engineer, wise administrator, inspiring leader, loyal friend, Admiral Earle was honored by faculty and students alike for his great attainments, and deeply loved for his simple, human qualities. The offices left vacant by his death have been temporarily filled by the appointment of Professor Francis W. Roys, head of the Mechanical Engineering Department, as acting president of the college, and of Dr. George I. Rockwood as acting chairman of the Corporation.

COLLEGE NOTES

Brooklyn Polytechnic Institute.—New curricula leading to the degree of bachelor of metallurgical engineering and bachelor of aeronautical engineering, respectively, have been added to the program of the Institute.

Although many of the subjects embraced in the new curricula have been offered for years, either as required or elective prerequisites to the mechanical engineering degree, the growing demand for students specially trained in both metallurgy and aeronautics has been responsible for the inauguration of the new degree curricula. The matter has been under consideration for some time, but the decision to offer the courses was not made until careful analyses had indicated that definite opportunities for students existed in both fields.

Case School of Applied Science.—The Chemical Engineering Laboratory, which has been completed at a cost of more than $300,000 and which is the first unit of a group to be devoted to Department of Chemical Engineering, was dedicated on Saturday, April 15. At a luncheon which preceded an inspection of the building, William Reed Veazey, of the Dow Chemical Company, of Midland, Mich., former professor of chemical engineering at the Case School, was the principal speaker.

The new building which is now in course of being occupied provides facilities for teaching and research in physical and organic chemistry, chemical engineering and plant design and offices and research laboratories for the staff. The main unit comprises three floors and a basement; an annex of two stories adjoins this. The main building is 104 feet long and 61 feet wide; the annex has a frontage of 44 feet and a depth of 60 feet. Constructed of steel and concrete with a shale brick exterior, the building is of modern industrial type with a maximum of natural light which is provided through a continuous run of windows along the full length of each floor.

Laboratories in the new building include those for unit operations, senior development, organic chemistry, physical chemistry, fuels, water and lubricants and chemical engineering. The latter will be located in the two-story annex which will provide space for larger apparatus for use in distillation, absorption and evaporation. Also included are seven offices with private laboratories, an aux-

iliary research laboratory and three recitation rooms. Service rooms include a mechanics' shop, mechanical store room, grinding room and drying room in the basement; furnace room, students' shop and balance room on the first floor; instrument room on the third floor, while in a pent house is an automatic distilled water system and ventilating fans to insure change of air in all laboratories and offices at intervals of from four to six minutes.

The building will care for approximately 40 per cent of the space needs of the Chemical Engineering department. Until additional units are constructed, work in general chemistry, quantitative and qualitative analysis and graduate work in many fields must be continued in the 44-year-old building. The old building will continue to house the chemistry library.

March 23, 1939, the 71st anniversay of the granting of the charter of the **University of California,** was set aside as University of California Day at the Pacific International Exposition on Treasure Island in San Francisco Bay and celebrated with special musical and educational activities. This was no more than fitting, because, of the many educational displays at the exhibit, that of the University of California has been one of the most popular drawing cards since the opening day of the Exposition. It was constructed at a cost of nearly one-quarter of a million dollars.

The University exhibits utilize a wide variety of media, including posters, transparencies, murals, all kinds of models, electrified and mechanized maps, dolls, models, and enlarged projections of microscopic views of living organisms. There are numerous exhibits of the sort at which the visitor presses a button to start an intricate and entertaining sequence of events or reactions.

The variety of subject matter is equally extensive. The Medical School displays an elaborate group of transparencies on the prevention and treatment of disease, a series on human development from prenatal to senility. The Anthropology Department shows an illuminated map tracing the migration of the seven races of man. Another very popular exhibit shows a group of mechanized dolls from whom the visitor selects two parent dolls. "Children" and "grandchildren" then arrange themselves, illustrating the principles of Mendelian heredity applying to color of eyes and hair.

Also, in the life sciences are agricultural exhibits of plants grown by artificial light and feeding, of water culture plant food deficiency experiments, paleontological still life models, and rare flower exhibits. Pest control exhibits including enlarged projections of battles between actual living parasites and their controlling enemies constitute a major attraction in this group.

In the physical sciences, the astronomical exhibits include mod-

els illustrating the behavior of the solar system and numerous photographic sequences. Chemistry exhibits include an elaborate "periodic series" in which seventy of the elements are on display. An extensive demonstration of liquid air attracts much interest. Physics contributes a full scale "operating" model of the now famous cyclotron and illustrates its use in atomic disintegration processes. An elaborate acoustical exhibit is also demonstrated.

Of most interest to the engineering visitors, as well as to the very many laymen impressed by the two beautiful new bridges across San Francisco Bay and the Golden Gate, is the accurate scale model of the Bay Bridge. Moreover, this is a "working model" nearly twelve feet long and carries a stream of miniature automobiles and trucks. When traffic is momentarily heavy on the center span, the actual bridge center is depressed over eight and one-half feet; and when traffic is heavy on the two ends, the center rises six feet. This behavior of the bridge is accurately illustrated on the model, thus giving a graphic representation of the beautiful flexibility of the structure. The model is of additional interest to those who recall that the final design of the bridge itself was reached by use of similar, but considerably larger, scale models in the University's Engineering Material Laboratories.

Altogether, the University of California's exhibits indicate that it seriously considers the Exposition a further opportunity to fulfill its function as a State institution, the function of educating the people of the West.

The Ordinance Department of the United States Army will establish a gage laboratory at the **Carnegie Institute of Technology** this spring, thus considerably increasing facilities for research and industry in the Pittsburgh district. The primary purpose of the laboratory is to make available standard measurements of the greatest accuracy for the machines which produce Army equipment. More than $20,000 worth of delicate precision instruments, accurate to the hundred-thousandth and millionth of an inch, will be installed in a laboratory.

The equipment makes possible measurements within two-millionths of an inch by means of the Van Keuren light wave equipment used to determine the wear on Johanssen precision measuring blocks or diameters of ball bearings and similar measurements where great precision is essential. Another piece of equipment measures length to the hundred-thousandth of an inch. Other apparatus includes a screw thread testing machine, comparators, microscopes, micrometers, surface plates, straight edges, levels, parallels, and squares. All precision equipment has been calibrated at the U. S. Bureau of Standards, and the tabulated calibrations are part of the laboratory records.

Colorado School of Mines.—The central section of the new Geology-Geophysics building which the geology department is occupying this semester for the first time, is completed and the two wings, which will double the floor space, are expected to be ready to occupy next September. The building has been planned with an eye to the future, the size and number of laboratories being sufficient to accommodate a large increase in enrollment. A complete air-conditioning system is a feature of the building. Wood furnishings are of hardwood and are finished in an attractive silver gray color. Floors are finished in terrazzo. The main floor has the departmental offices, the geology library, and a large lecture room. The second floor accommodates the petroleum and microscopic laboratories and lecture halls, and the mineralogy, ore deposit and ceramic laboratories are on the third floor. The basement has storage rooms for the various geology departments, a vault, a drafting room and a study room. When the wings are completed, one will house the geophysics department and the other the museum.

A model turbine runner for exhibition purposes in the mechanics fluid laboratory has been received from the I. P. Morris Division of the Baldwin-Southwark Corporation.

Additions to the faculty for the spring semesters are J. Ross Reed, E.M. and E.Met., Colorado School of Mines, instructor in Metallurgy; Frank R. Campbell, B.S. in mechanical engineering, instructor in mechanical engineering; and Harold M. Herreman, A.B. in physics, University of California, and formerly teaching assistant at that university, instructor in mechanics.

Harvard University.—Apparatus enabling the first completely automatic measurement of the velocity of light has been developed at the Physics Laboratories by Wilmer C. Anderson, Research Fellow. The new equipment is to be used in a long-term research project on the important question whether the speed of light is constant. Many important theories and measurements of physics and astronomy are based on the assumption that light-velocity is constant under all conditions. But the evidence of past velocity measurements is inconclusive on this point.

Dr. Anderson's apparatus is the first light-speedometer which has not required visual observation by the human eye, and which has been able to eliminate friction as a possible source of error in the measurement. At the present stage of development it can measure the speed of light with an error range of only two and a half miles per second. It is believed the equipment will give the most accurate light-velocity measurements ever secured. The experiments, leading to the construction of the present apparatus, have been under way for three years, and have been financed in part by the Carnegie Institution, of Washington, D. C.

The first attempt to measure the velocity of light was made by Galileo (1564–1642) whose plan of visual observation of lamp-light speed between mountain tops failed because of the great velocity of light. The first successful measurement was made by Roemer, a Danish scientist, in 1676, who observed that the light of the moons of Jupiter took 22 minutes to cross the earth's orbit. This value has since been found to be about 16½ minutes. Roemer's speed calculation was about 192,000 miles per second. This was confirmed and refined in 1728 by stellar observation by the English astronomer Bradley.

The first laboratory observations were made in 1849 by the French physicist Fizeau, using a revolving disk furnished with rim-teeth, cutting a beam of light hundreds of times per second. This method was carried on by Cornu in 1874. In 1862 Foucault utilized a rapidly revolving mirror in light-velocity apparatus. This method was developed by Simon Newcomb and by the late Dr. A. A. Michelson of the University of Chicago.

The **State University of Iowa** is offering a special three-week course (June 12 to June 30, 1939) for people in industry, and an eight-week course for college and university instructors, and for undergraduate and graduate students (June 12 to August 4, 1939).

These courses are intended for people interested in comprehensive training in motion and time study, waste elimination, cost reduction, plant lay-out, and related subjects.

Although this work has been offered regularly by the University during the school year, this is the first time these courses have been offered during the summer.

The Summer Management Course will be under the direction of Ralph M. Barnes. Assisting in the course will be six University instructors and lecturers and nine visiting managers and engineers from industry who will conduct forums on practical production problems.

The University of Iowa is well known for its instruction in industrial engineering and the results of research in this field carried on in its laboratories are receiving wide attention by manufacturers.

The three-week course is arranged for people from industry who want to obtain practical training in cost reduction methods.

Eight-week courses offered for students and college instructors will meet the demand for college graduates and teachers who want fundamental training in simplifying factory and office work.

University of Louisville, Speed Scientific School.—A Division of Industrial Research has been organized within the Speed Scien-

tific School, the purpose of which is to assist small industries having no research staffs of their own. This new division has the privilege of drawing on the science facilities (both personnel and materiel) of the different schools and colleges of the University for assignment of research work bearing on specific projects. The Dean of the Speed Scientific School will act as director of the division until such time as the division has become self-supporting and can justify the employment of a full-time director.

The civil engineering curriculum has added a course in Photogrammetry in the senior year.

The department of chemical engineering, under the direction of Dr. R. C. Ernst, has been doing considerable research work on "Drying," some results of which were reported in the October, 1938, issue of *Industrial and Engineering Chemistry*.

Accommodating 200 students, the new **Michigan College of Mining and Technology** dormitory will be ready for use on September 26, 1939, the first day of registration for the College's fifty-fourth year. The new building will be one of the most comfortable, commodious, and beautifully situated student-homes in Michigan.

It will be completely fireproof, in Tudor-Gothic style, and constructed of red brick, with stone trim, copper roof, and metal casement windows. The building is to be set well back from College Avenue.

Students living in the dormitory will be divided into two groups, each group having its own living room, game room, lobby, and similar facilities. An ample interconnected dining room and kitchen have been provided for.

The game room, in the basement, will extend the width of the central section of the building. All present game facilities found in the College clubhouse, except the bowling alleys, will be included in the new building, and on a larger scale.

North Carolina State College.—This institution has been chosen as one of thirteen engineering schools to work with the Civil Aeronautics Authority in training airplane pilots and mechanics. The training on the campus will be given in a newly-formed Pilots and Mechanics Training Department, under the direction of Professor L. R. Parkinson. Coöperating with the engineering school in the training program are the local airport and the National Youth Administration, the latter placing here many of its more capable members, who will be trained as mechanics.

In making the adjustments incident to this new work, the department of Mechanical Engineering has transferred to Aeronautical Engineering Professor C. N. Sanford. His present work is taken over by Professor W. E. Adams, B.S., Ohio University.

With the College Extension Division it arranged for the annual Engineers' Institute, January 26. The topics for the institute this year was "Soils and Soil Stabilization." Lectures came from members of the soils and geology faculty, as well as from visiting highway engineers.

The local section of the society has presented during the year a series of papers by members of its own departmental faculties, centered on the problem of better coördinated teaching. In addition to its own faculty, the group was addressed by Professor W. J. Seeley, of the Department of Electrical Engineering, Duke University.

The huge building program now has many units nearing completion. While few of the new buildings affect directly the engineering school, it will benefit by the general relieving of congestion in classroom and laboratory.

Rensselaer Polytechnic Institute.—E. H. Praeger, of New York City, has been named head of the civil engineering department to succeed Thomas R. Lawson, who will retire at the end of the year after forty years as a member of the Institute's faculty. Professor Lawson has directed the department since 1921. Mr. Praeger was graduated at Rensselaer in 1915.

Mr. Praeger for the last several years has been chief engineer for Madigan-Hyland, consulting engineers for Park Commissioner Robert Moses, of New York, in the group of major parkway projects for the West Side Improvement, Henry Hudson Parkway Authority, Marine Parkway Authority, New York City Parkway Authority, Bronx Whitestone Parkway, Circumferential Parkway, and New York World's Fair Site Improvement. He was consulting engineer in the development of Jones Beach and other State parks on Long Island and in the construction of several buildings on the World's Fair grounds.

A separate department is being established at the Institute for greater emphasis on the studies of forces and motion, and the testing of materials of which structures and machinery are made. It will be directed by Le Roy W. Clark, professor of mechanics at the Institute since 1921.

To increase its training and inquiry in these phases of engineering, under way many years, the Institute in addition to establishing a separate department will expand its materials testing laboratory.

Professor Clark was graduated at Rensselaer as a civil engineer in 1906. For the last twenty years he has been in charge of the Institute's buildings in addition to his teaching.

Swarthmore College.—There has been no change in the personnel of the instructing staff in the Division of Engineering.

The following laboratory equipment has been installed within the last year:

For stress determination, a 4¼ in. aperture Photoelastic Polariscope complete with "white" light source and mercury light source, as manufactured by the Polarizing Instrument Company. For use with this, a loading frame has been designed and built in our shops and an annealing furnace has just been completed.

The new electrical laboratory equipment consists of two matched motor-generator sets arranged to have the same shaft height and flange couplings so that they may be connected mechanically in any combination, in accordance with our standard laboratory practice.

The alternating current machines are arranged to operate as either a synchronous motor or generator, 3-phase, Y-connected, 15 horsepower, single circuit winding, with amortiseur bars reduced to reduce the damping effect. The direct current machines have a rating of 15 horsepower, compound wound with interpoles, normal operation with series fields in series and arranged for parallel grouping to increase the series effect. The machines are capable of carrying at least 130 per cent of full load current when operating as shunt generators without becoming unstable. The shafts of all four machines are extended so that they may be coupled in any manner. The direct current commutators are oversized to facilitate determining flux distribution in the air gap.

Equipment in the electrical engineering shop consists of a Gorton engraving machine; a South Bend precision screw cutting quick change gear bench lathe; drill press, grinder, saw for bakelite, small tools and cases for supplies.

For metallographic work, a Bausch and Lomb ILS Metalloscope with carbon arc lamp and optical equipment for visual magnification up to 500 × and photographic magnification up to 2000 ×.

A new air compressor has been installed in the mechanical laboratory. It is a 2-stage unit (8 in. × 4¼ in. × 8 in. × 250 rpm) rated at 94 c.f.m. at 100-pound discharge pressure. The unit is motor driven through a V-belt drive by means of a 25 horsepower, 220 volt, 1750 rpm. induction motor.

Syracuse University.—Charles D. Luke who joined the faculty of the College of Applied Science in September, 1937, has been appointed Acting Head of the Department of Chemical Engineering, succeeding the late Lloyd Logan who passed away last December.

In 1929 Dr. Luke was graduated from the State University of Iowa and afterwards matriculated at the Massachusetts Institute of Technology, where he was awarded the degrees of Master of Sci-

ence, and Doctor of Science in Chemical Engineering. While a student at the Institute, he served as an assistant in the Research Laboratory of Applied Chemistry and in the summer of 1931 assisted W. K. Lewis in the Petroleum Summer School. Additional time was spent by Dr. Luke in consulting work with the M. W. Kellogg Co., Merrimac Chemical Co., Standard Oil Company of N. J., and the E. I. du Pont de Nemours & Co. This work involved the design of distillation and absorption equipment and research on catalytic processes.

After leaving the Institute, Dr. Luke served in the Process Engineering Department of the Standard Oil Company of Louisiana in Baton Rouge, where his time was spent in plant test work, laboratory research and economic surveys of new processes. Later he was on the staff of Mr. Luis de Florez, consulting engineer of New York City. During this period he was engaged in plant test work, design and operation of cracking units, refinery surveys, cost analyses and consultation with refineries on cracking research and development. Considerable time was also spent in pioneer research in refineries and in the laboratory on the chemistry of cracking, in connection with legal matters with which the firm was concerned.

SECTIONS AND BRANCHES

The fourth annual meeting of the **Allegheny Section** of the Society was held on November fourth and fifth, 1938, at the University of Pittsburgh. The institutions represented were Carnegie Institute of Technology, West Virginia University, Pennsylvania State College, University of Pittsburgh, and Bucknell University.

The general session was held on Friday afternoon, November fourth, in the auditorium of Mellon Institute, L. C. McCandliss, University of Pittsburgh and President of the Allegheny Section presided. An address of welcome was delivered by Rufus Fitzgerald, Provost, University of Pittsburgh, followed by the response by Charles S. Keevil, Bucknell University and Vice-President of the Section.

The minutes of the Third Annual Meeting held at West Virginia University, October 22–23, 1937, were published in the May, 1938 JOURNAL OF ENGINEERING EDUCATION and were not read in the meeting. Professor Keevil invited the section to be the guests of Bucknell University for their annual meeting in 1939. The invitation was unanimously accepted. G. P. Boomsliter, West Virginia University and Chairman of the Nominating Committee, presented the following nominations:

President, Charles S. Keevil, Bucknell University
Vice-President, Emerson M. Pugh, Carnegie Institute of Technology
Secretary-Treasurer, Dalzell M. Griffith, Bucknell University

The report was accepted and the officers were elected by unanimous vote.

Leo Wolman, Professor of Economics at Columbia University and Member of the Staff, National Bureau of Economic Research, spoke on the subject: The Effect of Labor Unions on Engineering Graduates and on Engineering Schools. Dr. Wolman discussed the effect of labor unions on engineers, stating that union membership should be a private, voluntary affair. He urged, however, that engineering schools should acquaint students with labor problems before graduation.

The subject was discussed by W. E. Hotchkiss, Director of the Department of Industrial Relations, Carnegie Institute of Technology, and B. T. Boughton, Managing Editor, *Engineering News-Record.*

The annual dinner was held on Friday evening, at the Faculty

Club in the Cathedral of Learning. After the dinner an address, How our Economic Scheme Works, was given by Charles S. Tippetts, Dean of the School of Business Administration, University of Pittsburgh. Most of the guests then inspected the Cathedral of Learning.

Friday afternoon the ladies attended a tea in the lounge of the Faculty Club, and visited the International Art Exhibit, Carnegie Institute Art Galleries. Friday evening they attended the convention dinner. On Saturday morning they inspected the Stephen C. Foster Memorial and Mellon Institute.

Departmental Conferences

Saturday morning, November 5, 1938, five group conferences were held from nine to eleven o'clock.

The conference on Chemical Engineering was held in Room 202 of State Hall with W. W. Hodge, West Virginia University presiding, and W. E. Brinker, University of Pittsburgh, the secretary.

Before starting the discussion of the subject, Orientation Methods in Chemical Engineering Teaching, a tribute was paid to the memory of Professor H. C. Bashioum, who was to have presided over this meeting, but who died suddenly on October 30, 1938. Professor Brinker briefly told of Professor Bashioum's life and accomplishments, and the group paused in silence for a minute to show their respect for his contribution to the profession and to society.

Professor Hodge called upon Professor Brinker to start the program by outlining the methods used by Professor Bashioum at the University of Pittsburgh in an effort to assist the students to become oriented more quickly in the chemical engineering field. Each of those in attendance made a firm contribution to the program and gave the methods used at his respective school. There were many ideas presented and discussed, and a most beneficial transfer of thought took place. Dean Holbrook summarized the thought of the group and pointed out the methods in use in general at the University of Pittsburgh better to orient the student. The meeting was adjourned to the chemical engineering laboratory before going to the Mellon Institute for an inspection trip.

The conference on Civil Engineering was held in Room 212 of State Hall with A. Diefendorf, University of Pittsburgh presiding, and D. M. Griffith, Bucknell University as secretary.

Soil Mechanics was the subject discussed at this meeting. Professor Diefendorf opened the discussion by telling what work was being given in soil mechanics at the University of Pittsburgh. He stated that the work was included in a materials course for juniors.

He then asked representatives of the schools in the section to tell what work was given in soil mechanics in their respective schools.

Dean Davis, West Virginia University, said that they were not yet giving the work in class, and that it probably would be given in the mechanics department. Professor McCullough, Carnegie Institute of Technology, stated that they had not found room in the curriculum for soil mechanics, but that a man had been invited in last year to give a few lectures on the subject. Professor Minchell, Pennsylvania State College, described their soil mechanics laboratory. He said that certain physical tests had been placed in with the cement laboratory tests, and that a lecture course was given to senior Civil Engineering students. Professor Griffith, Bucknell University, stated that they were including the work in soil mechanics in a course in foundations.

Professor Thomas, Carnegie Institute of Technology, suggested that we use the term soils engineering instead of soil mechanics. R. M. Hoyt, Solvay Sales Corporation, expressed the opinion that few men actually know soils. He believes that a large number of men should know how to give the routine work in soils. He said it is a question of basic engineering, and not so much soil mechanics. Professor McCandliss stated that students should know the technical terms of soil mechanics so that they can talk intelligently when they get out of school. He said we cannot put out highly skilled men in soil mechanics. We should get the information from a few graduate schools and apply it in routine tests. Professor Downs, West Virginia University, said that the problem of the highway engineer is to stabilize soils. There is a different problem in dealing with structures and dam construction. He suggested giving an introduction of soil mechanics to undergraduates and then those who get into that work can go on with further study of it.

The Conference on Electrical Engineering was held in Room 105, Thaw Hall, with H. E. Dyche, University of Pittsburgh, presiding and R. C. Gorham, University of Pittsburgh, as secretary. The topic for discussion was: The Place of Electronics in Non-Electrical Engineering Courses. Formal discussion was presented as follows: (*a*) History and Present Trends—P. E. Rush, University of Pittsburgh. (*b*) Specific Applications via Laboratory Experiments—R. W. Ahlquist, University of Pittsburgh.

Informal discussion followed the formal discussion, in which every one present participated freely.

The final part of the morning program included an inspection trip through the Electronic Laboratory of the University of Pittsburgh where several experiments in electronics for non-electrical engineers were demonstrated.

The Industrial and Mechanical Engineering Conference was

held in Room 103, State Hall with H. H. Rothrock, University of Pittsburgh, as chairman, and W. R. Turkes, University of Pittsburgh, as secretary.

The Chairman presented the general subject, The Value of Shop Courses in Industrial Management, at which time he explained that the subject might have been stated better, The Value of Shop Courses to Engineering Curricula. Charles C. Leeds, Carnegie Institute of Technology, presented the paper, Shop Courses from the Standpoint of Industrial Management. Following Professor Leeds' paper, the chairman called for discussion on the general subject. When asked to explain briefly student reports and inspection trips as they were handled at his school, Professor Leeds replied that they had four objectives in mind in making field trips, which were: (1) Training of students to observe accurately; (2) Training in report writing; (3) Industrial orientation; and (4) A study of types of manufacturing. He further stated that he personally corrected all student reports.

Professor Hayes, West Virginia University, opened the discussion of the general subject by stating their experiences where the E. C. P. D. requirements necessitated the scaling down of shop courses to provide time for required theoretical subjects.

The question was raised concerning the justification of old machines in school shops, the like of which the student would never find in industry. Professor Leeds explained that they were teaching fundamentals which could be learned on old machines as easily as new. He added that later equipment and information concerning mass production could be derived from the inspection trips their students were required to make.

In answer to the possible use of motion pictures as a substitute for shop work, W. H. Dosey, Carnegie Institute of Technology, explained the experience of some western schools in this field. It was his opinion that they were a poor substitute for actual work and that a new shop example each week preceded by a half-hour lecture was the best method of handling shops.

The trends of shops in the past nine years at the University of Pittsburgh was discussed by Professor Dent of that school.

The conference on Mechanical Drawing was held in Room 101, State Hall, with A. L. Tobias, Pennsylvania State College presiding and W. I. Short, University of Pittsburgh, the secretary.

The meeting was informal and all those in attendance entered the discussion on the subject, The Introduction of Descriptive Geometry very Early in the Drawing Course.

Following the meeting the drawing laboratories of the Univer-

sity of Pittsburgh and of Carnegie Institute of Technology were inspected.

DALZELL M. GRIFFITH, *Secretary-Treasurer*
Allegheny Section, S. P. E. E.

The twenty-third annual meeting of the **Kansas-Nebraska Section** was held at the University of Nebraska, Lincoln, Nebraska, on October 21 and 22, 1938, with the University of Nebraska acting as the host. Friday afternoon was spent in registration, visiting, and golfing.

At 6:15 P.M., Friday, October 21, all met together at the new Student Union Building on the University of Nebraska campus for a dinner. Entertainment was furnished immediately after the dinner by a young men's trio.

Chairman Boyce then called the meeting to order and presented Dean O. J. Ferguson of N. U. who, in turn, introduced the main speaker of the evening, Chancellor C. S. Boucher, of N. U.

A nominating committee consisting of W. L. DeBaufre, N. U., R. G. Kloeffler, K. S. C., and F. A. Russell, K. U., was appointed.

The meeting was adjourned then to the departmental meetings as listed below:

Applied Mechanics, Civil Engineering, and Mechanical Engineering, joint meeting, Room 206, Mech. Engr. Bldg.
Co-chairmen: E. R. Dawley (K. S. C.), G. W. Bradshaw (K. U.), A. A. Luebs (N. U.).
Subject: The Interrelationship of Hydraulics, Thermodynamics and Fluid Mechanics. Presented by J. H. Robert (K. S. C.).

Agricultural Engineering, Room 205, Mech. Engr. Bldg.
Chairman: C. W. Smith (N. U.).
Subject: E. C. P. D. Standard Curriculum.

Architecture, Room 24, Temple Building (12th & R Sts.)
Chairman: L. B. Smith (N. U.).
Subject: Domestic Architecture (Tour of inspection Saturday morning).

Chemical Engineering, Room 5, Avery Laboratory (12th & T Sts.)
Chairman: C. J. Frankforter (N. U.).
Subject: Curriculum in Chemical Engineering for Mid-Western Institutions.

Electrical Engineering, Room 204, Mech. Engr. Bldg.
Chairman: L. A. Bingham (N. U.).
Subject: What Are Our Objectives in Giving Quizzes?

Engineering Drawing, Room 207, Mech. Engr. Bldg.
Chairman: F. A. Smutz (K. S. C.).

Subjects: (1) Gleanings from the meeting at College Station. T. T. Aakhus (N. U.).

(2) Objectives of the Drawing Courses in Engineering Education. F. G. Higbee, Head of Drawing Department, University of Iowa.

(3) Discussion. Professor Hood and Others.

Mathematics, Room 304, Mechanic Arts Bldg.
Chairman: W. T. Stratton (K. S. C.).
Subject: Teaching Problems in Engineering Mathematics.

On Saturday at 8:30 A.M. the Agricultural Engineering Department gave a demonstration of their tractor testing equipment at the agricultural campus of N. U. At 9:30 A.M. Chairman Boyce again called the meeting to order in the Student Activities Building on the agricultural campus. Reports were given of the round-table or departmental meetings held the previous evening.

The nominating committee then brought in their report and nominated the following for officers for the next year:

President: C. E. Pearce, K. S. C.
Secretary: M. I. Evinger, N. U.
Program Committee: T. H. Marshall, Chairman, K. U.
J. P. Colbert, N. U.
F. F. Frazier, K. S. C.

The chairman asked for advice regarding disposition of $2.50 that had been received from the general secretary of S. P. E. E. representing the refund to the section of 50 cents each for five members who had paid the full $5.00 dues to the general secretary before January 15, 1939. After considerable discussion a motion carried that the 50 cents be refunded to the men who paid it.

Roy M. Green of the Western Laboratories of Lincoln, Nebraska, then read a paper on "New Situations Confronting the Young Engineer." This was followed by a panel discussion led by W. L. Faith, K. S. C., I. C. Crawford, K. U., and O. J. Ferguson, N. U. Mr. Green then gave some closing remarks. It was moved, seconded, and carried that efforts be made to have Mr. Green's paper published in the S. P. E. E. JOURNAL.

After luncheon Dean Crawford issued an invitation to meet next year at K. U. The invitation was accepted.

Total attendance: 122 men, 45 ladies.

O. D. HUNT,
Secretary.

Newly Appointed Chairmen

Applied Mechanics—Brown, F. L., K. U.
Civil Engineering—Morse, Reed F., K. S. C.
Mechanical Engineering—King, Jno. H., K. U.
Agricultural Engineering—Barger, E. L., K. S. C.
Architecture—Kellog, Joseph, K. U.
Chemical Engineering—Marshall, T. H., K. U.
Electrical Engineering—Hessler, V. P., K. U.
Engineering Drawing—Kurtz, J. W., Omaha Univ.
Mathematics—Brenke, W. C., N. U.

The seventh annual meeting of the **Pacific Southwest Section** was held at the University of Santa Clara on December 27, 28, 29, 1938, with an attendance of about fifty, representing seven colleges, five junior colleges, and one publisher, as well as three practicing engineers.

The Reverend Louis C. Rudolph, S.J., President of the University of Santa Clara, gave the address of welcome.

The following papers and discussions were presented:

Report on the Annual Meeting of the Society of Texas A. & M. College, Franklin O. Rose, University of Southern California. Discussion by J. W. Hazen, Los Angeles City College.

Progress in Curriculum Accrediting, G. W. Butler, University of Arizona. (Read by A. B. Domonoske, Stanford University.)

Problems and Records of Transfer Students at Stanford University, Samuel B. Morris, Stanford University.

Changes Made Since the Corvallis Convention of 1936, R. E. Davis, University of California.

Hydraulic Laboratory Instruction at the University of California, R. G. Folsom, University of California.

Problems of Instruction in Materials Testing, H. E. Davis, University of California.

Laboratory Instruction in Electrical Engineering at the University of California, Abe Tilles, University of California. Discussion by B. M. Green, Stanford University.

Present Trends in Heat Power Engineering, E. D. Howe, University of California. Discussion by T. T. Eyre, University of Southern California.

Relation of Mechanic Arts to Engineering, H. C. Amens, University of Nevada. (Read and discussed by I. J. Sandorf, University of Nevada.)

The Constitution of the United States, Rev. C. F. Deeney, S.J., University of Santa Clara.

Distribution of Conventions, Comments on paper by Ex-President

Williams, I. J. Sandorf, University of Nevada. Discussion by J. C. Clark, University of Nevada. (Read by I. J. Sandorf.)

Coöperation Between Practicing Engineers and Educators, A. V. Saph, Consulting Engineer, San Francisco. Discussion by P. S. Biegler, University of Southern California.

The Educational Value of Honor Societies, Franz Schneider, University of California. Discussion by A. B. Domonoske, Stanford University.

Civil Engineers' Registration Law of California, H. D. Dewell, President, State Board of Registration for Civil Engineers.

Counseling Prospective Engineers in High School, Junior Colleges, and Freshman College Classes, F. T. Shipp, San Jose High School, J. C. Elder, San Jose State College, J. A. Carpenter, University of Nevada. Discussion by J. M. Robb, Taft Junior College.

The ladies were entertained by luncheons, teas, and visits to local points of interest under the able leadership of Mrs. G. L. Sullivan.

On the first evening members and ladies listened to a delightful recital by Rev. E. M. Bacigalupi, S.J., a member of the University of Santa Clara faculty, illustrating the contrasts between German and Italian grand opera.

For the men, the latter part of the first afternoon was given to an inspection trip through the near-by plant of the Rosenberg Packing Company, which processes and packs prunes, apricots, walnuts, and fruit pits.

Part of the second afternoon was spent in inspecting the University laboratories and the Santa Clara Mission. H. B. Langille, University of California, had on display some interesting examples of early machine drawings, mostly German, dating from 1827. In the physics museum of the University are pieces of apparatus which were brought around the Horn in sailing ships.

An informal banquet was held on the second evening in the University Dining Room. The address was given by H. J. Brunnier, Consulting Engineer of San Francisco and assistant engineer on the Bay Bridge. His talk, entitled "The Bridges," informed us as to the financial considerations during promotion and design.

The entire third afternoon was devoted to an inspection trip to Treasure Island, the site of the 1939 Golden Gate International Exposition. This large island is entirely artificial and is connected to San Francisco by the new Bay Bridge. The extensive landscaping and exposition buildings are well on toward completion and a very good idea could be obtained of the general appearance of the Fair.

It was decided to accept the invitation of the University of Nevada to hold the eighth annual meeting on their campus at Reno. The dates are to be December 28, 29, 30, 1939.

The following officers were elected for 1939:

Chairman: F. H. Sibley, University of Nevada.
Vice-Chairman: P. S. Biegler, University of Southern California.
Secy-Treas.: B. M. Green, Stanford University.
New members of Executive Committee: T. C. Adams, University of Utah; S. A. Francis, San Mateo Junior College; H. H. Wheaton, Fresno State College.

BOYNTON M. GREEN,
Secretary-Treasurer.

Leslie M. Oliver, Associate Professor of English, Colorado School of Mines, has been appointed Chairman of the **Rocky Mountain Section** of the Society. The annual meeting of the Section will be held on this campus Saturday, April 15. The general subject for discussion will be "The Problems of Building Engineering Curricula," and about half the program time will be given to that subject. Half of the program will be devoted to other subjects of interest to the section.

The **Middle Atlantic Section** will hold a meeting on May 6, 1939, at Swarthmore College, Swarthmore, Pa.

BOOK REVIEWS

Mechanical Engineering Science—A Second Year Course. MORLEY AND HUGHES. Longmans, Green Co. Price, $1.75.

The book is written especially for what is known in Great Britain as a second-year part-time senior course in mechanical engineering and assumes a first year course in statics and heat following a preparatory course including elementary mathematics and physics. The three broad divisions into which the book is divided are: kinematics and kinetics, mechanics of fluids, and thermodynamics including steam power.

Due to the scope covered obviously only the more elementary fundamentals are considered. An understanding of calculus is not presupposed and hence the derivation of some of the equations are necessarily a little awkward. The subject of thermodynamics is treated by means of the mechanics of an ideal gas and the principles developed in the section on mechanics are used as an aid in explaining the heat equations.

A number of problems are included at the end of each chapter with their answers in the back of the book. A condensed table of the properties of saturated steam along with several other tables of mathematical and physical constants is also included.

T. G. BECKWITH

Heat Engines. A. C. WALSHAW. Longmans, Green and Co., 413 pages, $2.75.

This book, intended as an introduction to the study of heat power, is very complete and easily understood. Graphs, diagrams, and illustrations of equipment are liberally used to make the explanations clear. Sample reports of tests on equipment are included in the text to illustrate this phase of the work to the beginner.

The book is divided into three parts:

I. Introductory Work on Heat and Heat Engines.
II. Steam and Steam Engine Plant.
III. Thermodynamics and Internal Combustion Engines.

In each instance the theory is first simply demonstrated and followed by the application to definite equipment. Exercises at the end of chapters are divided into elementary and more advanced groups with a distinguishing heading for each list.

Symbols and abbreviations are according to the British Standards Institution. British Thermal Units and Centigrade Heat Units are both used for the purpose of introducing both systems to the students, since both are used in England.

G. O. MANIFOLD

Advanced Mathematics for Engineers. H. W. REDDICK AND F. H. MILLER. John Wiley & Sons, Inc. New York, 1938; x, 473 p. $4.00.

The present book is designed as a text book suitable for students of civil, electrical, mechanical or chemical engineering. It may perhaps be fair to describe it as a course in advanced calculus written particularly for the engineering student. It does not attain the standard of logical rigor that should characterize a course in advanced calculus as such. On the other hand the authors, rightly I think, do not attempt to attain such a standard, preferring to concern themselves with the practical requirements of the engineer. To say, however, that the book does not rise to the logical standard of mathematics as mathematicians like it may possibly prove misleading, for the standard of logic which the text exemplifies is nevertheless reasonably high and far from unsatisfying. The book is written with a great deal of care, and pains have been taken to present important concepts, theorems, and physical laws with clearness and thoroughness.

A glance at the table of contents, will reveal the topics discussed: ordinary differential equations, hyperbolic functions, elliptic integrals, infinite series, Fourier series, Gamma and Bessel functions, partial derivatives and differential equations, vector analysis, probability, functions of a complex variable, and operational calculus. The methods of Picard and Frobenius for the solution of differential equations are included in the chapter on series, and the Schwarz-Christoffel transformation in the chapter on the complex variable. Function-theoretic methods utilizing Bromwich's line integrals appear in the treatment of operational calculus.

It is a matter for regret that the authors have not seen fit to include certain algebraical developments such as the solution of systems of linear equations and Graeffe's method for approximate solution of polynomial equations.

The reviewer is to this extent a mathematical heretic: he asks himself whether a course such as this is not of more value to the engineer than the traditional course in advanced calculus with all its compensating rigor. He believes, moreover, that the book could

be read with profit by pure mathematicians and by many physicists.

A. E. STANILAND

Introduction to Bessel Functions. F. BOWMAN. With Diagrams. Longmans, Green and Co. London, New York, Toronto. x, 135 p. $3.60.

The present book is intended to serve as an introduction to the larger treatises on the subject such as those by Watson and by Gray and Mathews. As such it serves its purpose admirably.

Bessel functions of zero order are first considered followed by a chapter on applications to certain ideal problems of physics, such as the small vibrations of a uniformly stretched uniform membrane. Thereafter are discussed modified Bessel Functions, related definite integrals, asymptotic expansions, and Bessel functions of arbitrary real order. The volume closes with a second chapter on applications including a treatment of Kepler's problem.

This book merits strong commendation. Simplicity and clarity characterize the exposition, which is both interesting and illuminating throughout. Excellent diagrams appear at appropriate places; and there are numerous tempting problems. The publishers have done a fine job with the typography and format.

A. E. STANILAND

Engineering's Part in the Development of Civilization. D. C. JACKSON. Reprinted from "Mechanical Engineering." American Society of Mechanical Engineers. New York City.

The six articles comprising this work were originally delivered as a series of lectures at the University of North Carolina State College and are now collected in book form.

Professor Jackson sketches the rise of man from a primitive condition to our present status, and emphasizes the part engineering has played in the ascent toward civilization. He defines civilization as "An advanced state of material and social well-being among men, which is associated with a sympathetic mutual interest between individuals and by individuals for community welfare. It connotes a developing or developed sense of comity among men." The reviewer feels that to this definition should be added "An advanced state of intellectual and esthetic development"—a most important ingredient in true "civilization." Under such a definition no present or past community can be classified as truly civilized. The author rejects the claims of former periods of high culture as lacking in the sense of comity. He shows that the advancement of engineering has been largely instrumental not only

in the improvement in physical well being, but in the development of this "sense of comity" which he stresses as an essential of true civilization. While we have not attained the goal, we have made great advances toward it. Civilization has not been yet achieved, but is in sight. In view of recent international developments one wonders whether the sense of comity has progressed as far as the author thinks—at least in the international field.

The attempt to cover so wide a field in a short series of lectures necessarily compels the author to make sweeping generalizations, and it would perhaps be unjust to criticise on the grounds that many exceptions might be taken to some of the broad statements offered. In a wider view it can be said that Professor Jackson makes good his thesis that the engineer has had a tremendous influence on the ethical as well as the material advance of the race. The lectures are stimulating reading and deserve a large and favorable audience.

JOHN A. DENT

An Introduction to Metallurgy. PROFESSOR JOSEPH NEWTON, of the University of Idaho, published by John Wiley & Sons, Inc., 514 pages + 23 pages of index. Net price $4.00.

This new text is a welcome addition to the literature available for introductory study and teaching in metallurgy. In general, it covers about the same field as that covered years ago by Sir W. C. Roberts-Austen, in his "Introduction to the Study of Metallurgy," and later by Professor Charles H. Fulton, in his "Principles of Metallurgy." It is not as extensive a text as Professor Hofman's "General Metallurgy," or Liddell's 2-volume work on "Hand Book of Non Ferrous Metallurgy." However, the presentation is concise and to the point; and the amount of detail easily sufficient for a rather extended first year's course in metallurgy. The various chapters are concluded with a list of literature references, and many chapters have lists of problems or exercises for students to work, both good features in an introductory text. It appeals strongly to the present reviewer in that the price is no higher than $4. Too many of our good metallurgy texts are priced so high as to overtax severely the limited means of many students.

After a brief introductory chapter, the book has two main subdivisions. The first, of some 185 pages, is called "Adaptive Metallurgy," and covers what may perhaps be called a brief scientific and practical study of physical metallurgy or metallography and heat-treatment of metals and alloys themselves, and their adaptation to various uses. The second subdivision treats mainly of the extraction of various metals, or in general the principles underlying the extraction, and the processes used therein, of the metals

from their ores and other metal bearing materials, and their refining and finishing as useful commercial metals, and or alloys, a subdivision of metallurgical engineering that may be well called production metallurgy, as it includes not only the mere extraction, but also the refining, and in many cases the finishing to commercial products.

The section on "Adaptive Metallurgy" has six chapters with the following headings: The Structure of Metals; The Structure of Alloys; The Physical Properties of Metals and Alloys; Shaping of Metals and Alloys; The Heat-Treatment of Metals and Alloys; The Industrial Metals and their Alloys.

Part "B," on "Extractive Metallurgy," contains nine chapters, respectively, on: The Sources of Metals; Ore Dressing; Hydrometallurgy; three chapters on Pyrometallurgy, 1, Chemical Principles, 2, Heat, 3, Processes; Electrometallurgy; Sampling and Related Topics; Production of the Industrial Metals.

STEPHEN L. GOODALE

Economics for Engineers. BOWERS AND ROWNTREE. Second Edition—1938. McGraw-Hill Book Co. 27 Chapters, 591 pages. Price $4.00.

This new second edition shows a marked growth over the first edition of 1931. It embraces even a wider range of subjects, than the first edition, including many controversial subjects, such as N.R.A., A.A.A., and T.V.A., etc. After sixty pages of introduction the authors continue with part II (the Business System) which is subdivided into such subtopics as Business Units; Domestic Marketing; Money and Money Systems; Credit and Banking; Price Trends and Money Theory; and International Trade and Finance. These subjects are discussed in a logical sequence but with no apparent attempt to emphasize or point out Engineering applications. The list of references for parts II and III are for the most part in the field of Banking and Financial studies.

As one progresses through the somewhat general treatment of topics from chapter to chapter he gets the impression that the authors have the idea that engineering students should read parts of everything there is to know about a large number of non-technical subjects which may or may not come up later in an engineer's thinking. Many or all of the subjects treated might well be studied by business administration students.

The material included is well divided into four parts as follows:

I. Introduction	Pages	3–60
II. The Business System	"	61–210
III. Value Theory	"	211–394
IV. Economic Problems	"	395–574

A wide variety of material is treated under these four main headings. The discourse is not any more mathematical than financial arithmetic. A very fine selection of review questions and problems are included at the close of each chapter under the caption of "Problems." There are a total of 181 such problems and there is a long list of references included at the close of each chapter.

R. C. GORHAM

Physical Meteorology. JOHN G. ALBRIGHT. Published by Prentice-Hall. 382 pp. Price $5.35.

This book is intended as an introduction to the physical explanation of important meteorological phenomena. The book assumes a general course in physics as a prerequisite. The student who has had a general course should be properly prepared for the material in this text—in fact this reviewer believes that in a few places the author might have leaned more heavily on the student's background. The methods of calculus are used in a few of the derivations, but they do not form an essential part of any of the arguments and so there should be no hesitation in using this book as a text for a group that have not studied calculus.

One of the outstanding features of this book is the large number of tables, graphs, and excellent photographs. At the end of each chapter general questions and a few problems are included. The problems are meant to illustrate the textual material rather than to extend it and are no more difficult than those given in an ordinary physics text. Although there is considerable descriptive material, wherever possible, explanations of phenomena in terms of fundamental physical principles have been given. Some of the topics that are treated with more than ordinary skill are: the reason for "prevailing winds" in certain localities; the explanation of the origin of hail; the explanation of the acceleration of Coriolis and its effects in causing the circulation of air; the discussion of the causes of hurricanes; and the discussion of the Bjerknes theory of the polar front.

In two respects, the text might have been made more acceptable to this reviewer. The discussion of Fourier series in Chapter VII is not essential to the general development, but on the other hand, in its present shape, it seems too brief to be understandable to a student with the degree of mathematical maturity assumed in other portions of the book. The other matter to which this reviewer objects is that of writing equations with the units included. For instance,

$$f = mv^2/r \text{ dynes.}$$

These matters are, however, of comparatively small importance, and considered as a whole, the author is to be congratulated for a clear and readable exposition of the subject.

MILLARD F. MANNING

Introductory Quantum Mechanics. VLADIMIR ROJANSKY. Prentice-Hall, Inc. 543 pp. Price $5.50.

This book is intended for students who are taking a rather comprehensive course in quantum mechanics rather than for those who are interested in the descriptive or the applied side of the subject. As a text for the serious student of this subject, this book has a number of very good points. The author has been very careful to indicate definitely the basic assumptions. He has also been careful to indicate where a rigorous discussion ends and a generalization is arrived at by plausible arguments. The discussion of the symbolic method is an example of a clear exposition of a not too simple subject. The author has followed the custom of segregating the portions which involve the purely mathematical discussion in sections by themselves so that the student can realize more clearly which conclusions are derived from physical arguments and which conclusions follow from formal mathematical arguments. This reviewer was favorably impressed by the thorough and unhurried manner in which the manuscript must have been prepared.

Some teachers will find themselves handicapped in using this book as the *only* text for a course in quantum mechanics because there is almost no mention of some of the interesting applications of quantum mechanics. There is no discussion of the structure of atoms more complex than hydrogen, and no discussion of the electronic structure of molecules and solids.

The binding and typography of the book have the usual high quality which we associate with the Prentice-Hall Physics Series.

MILLARD F. MANNING

Engineering Mechanics. SEIBERT FAIRMAN AND CHESTER S. CUTSHALL. Published by John Wiley & Sons. 263 pages. Price $2.75.

This is a good elementary mechanics text. It considers only those points that should be essential to any course in mechanics. This makes it unnecessary to omit large sections of the text as is necessary if a more complete book is used.

The arrangement of the subject matter in the book makes for easier teaching of the course. The first three chapters deal exclusively with co-planar forces so that the student has time to

acquaint himself with the essential principles of forces and equilibrium before he is confronted with a third dimension to complicate his problems. The first chapter is well chosen as to subject matter in that it gives the student the essentials of the study of forces all at one time so that he may use them as the occasion requires. This is better than the usual procedure of presenting only one principle at a time and then going into the applications of that principle.

The chapter on friction is well arranged so that there is a logical order in the principles treated under this subject. The section on axle friction is clear and concise.

In the study of centroids, the order of the chapter is very good. The study of center of gravity first and then the treatment of centroids makes it much easier for the student to visualize the meaning of "centroid."

Through the entire text the development of formulas and other equations is made as simple as possible so that the student need not have much more than a small amount of the calculus at his disposal to be able to follow and understand these developments.

The profuse use of examples does much to improve the book, since one well-chosen example is often as good as a whole page of explanation.

The problems are chosen so as to exploit every point of the work under consideration and the answers to the problems give the student a feeling that it is worthwhile to work the problem because he is able to check his work and know that his method is correct.

FRANK BROMILOW

G-E Campus News

MODERN TORTURE

THEY ARE hung by their thumbs, pulled by their toes, and put into furnaces for ten years.

These are the well-organized tortures conducted not by villains of a medieval novel but by G-E engineers. They are the "creep" tests conducted on sample rods of various steels before these steels are used in the manufacture of turbines.

As explained by E. L. Robinson, St. Lawrence, '11, Harvard Engineering School, '14, G-E engineer, the excessive heat under which a turbine operates softens the metal of which it is made, and the metal extends, or creeps. If this creeping exceeds a dimensional change of a hundred-millionth part per hour, or is not symmetrical and uniform, the turbine shell may leak or the speeding rotor may get out of line.

To avoid these troubles, types of alloyed steels that restrict creeping must be used. Therefore, the creep tests. Sample rods are held fast and stretched until they break. They are put into electric furnaces and kept there for as long as 10 years; temperatures as high as 1200 F being maintained. Careful inspection of the results shows whether the steel is of the proper type.

This creep test is only one of the many made on each G-E turbine. For many other engineers—veterans and Test men alike—conduct other exacting tests.

WORLD'S CHAMPION

SITTING complacently on his new throne in the G-E Research Laboratory is the new midget weight-lifting champion. Not only does he completely outclass other contenders, but it seems probable that he will continue to do so for some time.

This champion is the world's most powerful permanent magnet for its size. Even though he weighs only 1/250th of a pound, he is capable of lifting nearly 1500 times his own weight.

The midget is made of a material known as Alnico, introduced by the Research Laboratory as a heat-resisting alloy. Alnico magnets have been used for some time in radios, motors, generators, and other electric equipment, replacing electromagnets, which require current for their operation.

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